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THE

DIARIAN MISCELLANY:

CONSISTING OF

All the Uſeful and Entertaining Parts, both Mathematical and Poetical, extracted from the

LADIES' DIARY,

From the beginning of that work in the year 1704, down to the end of the year 1773.

With many additional

SOLUTIONS and IMPROVEMENTS.

In five Volumes.

VOL. I.

By CHA. HUTTON, F. R. S.
Profeſſor of Mathematics in the Royal Military Academy.

LONDON:

Printed for G. Robinson and R. Baldwin in Pater-noſter Row, 1775.

P R E F A C E.

THE late ingenious Mr. Thomas Simpſon, who was one of the worthy compilers of the original Ladies' Diary, ſpeaking of the merit of that little book, ſays "that for upwards of half a century, this ſmall performance, ſent abroad in the poor dreſs of an almanac (and that under a title, not calculated to raiſe the higheſt expectations) has contributed more to the ſtudy and improvement of the mathematics, than half the books profeſſedly written on the ſubject. The moſt celebrated authors now among us, have contributed to promote the reputation of the Ladies' Diary; and the compiler thinks he may, without any offence to truth, venture to pronounce, that the mathematical part (at leaſt) is, at this time, greatly ſuperior to every attempt to imitate it, and not below the notice of the beſt judges."

On this head I ſhall not enlarge, as the merit of this little annual performance is too well known and acknowledged, to need any more particular declarations of it in this place. I ſhall therefore only employ a few lines, by way of preface, in pointing out the motive for this publication of the diaries collected, with the plan on which it has been completed.

The extreme ſcarcity of the more early numbers of the diary, with the importance of the many curious particulars of which the whole conſiſts, had rendered a collection of the whole almoſt invaluable. And as it had long been found almoſt impoſſible to collect together any number of complete ſets of them, it was therefore earneſtly deſired that, from ſome one entire collection of them, a republication might be made of the moſt uſeful and entertaining parts extracted from the whole. In conſequence, ſeveral attempts were at different times made, by ſome ſpirited friends of the work, to collect a complete ſet, and to furniſh the public with an edition of ſuch extracts. Unluckily

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however, from various cauſes, their attempts generally failed on being carried into execution. Among the reſt, the editor of this collection, with much trouble at laſt completed an entire ſet, with the ſame laudable view; and by the kind aſſiſtance of ſome friends, and the generous encouragement of the public, he has been enabled to bring out this edition of the ſo long deſired work, from the beginning of it in the year 1704 to the end of the year 1773, including a period of 70 years.

Being aware of the difficulties attending the proper execution of this buſineſs, both with regard to the natural abſtruſeneſs and intricacy of many parts of the work, and to the aſcertaining of the beſt plan and method of conducting it; before I began to print any part of the book, I collected together all the aſſiſtance, in both reſpects, from many ingenious and learned gentlemen, who were well acquainted with the nature of the work, by whom I was ſupplied with ſeveral other corrected ſolutions, and from all their opinions concerning the plan or manner of printing, &c. I have been enabled to extract one which ſeemed to be the leaſt exceptionable of any, and according to it the work has been at length completed. Of that plan I ſhall now give a ſhort account.

Agreeably to the wiſhes of moſt people, the grand out-line reſolved on was, a republication of all or moſt part of the uſeful and entertaining articles of the work, viz. all the mathematical parts, and almoſt all the poetical or enigmatical ones. In two volumes therefore I have included theſe laſt-mentioned parts; having omitted only ſome ſmall things of leaſt value, as rebuſſes and paradoxes, with ſome few of the leſs elegant ſolutions of the enigmas where they were cumberſomly numerous. And in three volumes are included all the mathematics, both queſtions, ſolutions, tracts, and eclipſes. And here ſolutions have been carefully ſupplied where they were wanted, the erroneous ones corrected, and the obſcure ones explained and elucidated; alſo to the annual calculations of eclipſes are added accounts of the obſervations made of

of the ſame eclipſes collected from various publications, which it was thought might be of uſe in ſhewing the degree of nearneſs in the tables from which the calculations had been made, when the computers were ſuch as might be depended on: all which additions are printed in a ſmaller type by way of notes at the bottoms of the pages; ſo that the text or work itſelf is regularly diſpoſed without any interruption from them. All the parts are printed after the order of their dates; by which diſpoſition it very readily appears what each year's original diary conſiſted of, and from which it might again be eaſily recompoſed and thrown into its original form. The running titles at the tops of the pages are ſo contrived as to ſhew both the particular ſubject there treated on, the year's diary to which it belongs, the number of years it is from the beginning of the work, and the author or compiler of the work for that year. From theſe titles it appears that the 70 years include a ſucceſſion of five different authors, viz. Mr. John Tipper, the original projector and beginner of the work, from the year 1704 to 1713 incluſive; Mr. Henry Beighton from 1714 to 1744; Cap. Rob. Heath from 1745 to 1753; Mr. Tho. Simpſon from 1754 to 1760; and laſtly Mr. Edw. Rollinſon from 1761 till his death in 1773. Theſe are all the nominal authors that have conducted the work during the different years of its exiſtence: but beſides them there were ſome other perſons who have been at different times partly concerned with them in its management; ſo it is ſaid that for ſome years before the death of Mr. Beighton, the mathematical parts were compoſed by his friend Mr. Ant. Thacker, as being a better mathematician; and that for ſome time before and after his death, the enigmatical parts were managed by his amiable wife.

Of all theſe perſonages I had thought to have given here a ſhort hiſtory, as a proper appendage to this complete edition of a work in which they deſervedly acquired ſo much honour; but after many fruitleſs endeavours to procure proper materials for ſuch memoirs, I have been at laſt obliged to relinquiſh that favourite

favourite deſign for want of ſufficient papers relating to the lives of the more early compilers.

It may be perhaps not unneceſſary to obſerve that, in a few ſheets near the beginning of this work, the original orthography and other peculiarities of language are retained, where they appeared to have proceeded from deſign; but that in the reſt of the work throughout, the obſolete ſpelling and grammatical inaccuracies are moſtly altered agreeably to the preſent ſtate of our language; and the propoſing of a queſtion in bad verſe, has, in one or two inſtances which ſeemed to require it, been turned into plain proſe.

Finally, at the end of the laſt volume of poetry is added a liſt of the ſubjects of all the enigmas in chronological order. And at the end of the laſt volume of mathematics, an alphabetical liſt of all the diary writers, with the queſtions ſubjoined which each propoſed and anſwered; as alſo, an appendix, containing additional improved ſolutions to ſome few of the queſtions, with corrections of the material errors which had eſcaped notice in the printing, and which might affect the ſenſe of the reading. Other ſmaller inaccuracies are, by the editor, ſubmitted to the indulgence of the candid reader.

THE MATHEMATICAL PARTS OF THE LADIES' DIARIES.

1705

Of the Motions of the Sun and Moon.

THERE is is nothing more ſtrange and ſupriſing to ſome perſons, than the various motions and appearances of the ſun and moon. To ſee, for inſtance, the ſun riſe ſometimes due eaſt, and ſet due weſt, at other times to ſee him riſe and ſet a great way more northward, and at half a year after a great way more ſouth. To obſerve the days to increaſe one time in the year a whole hour in 15 days, and at another time not above 10 minutes in the ſame ſpace of time, and ſometimes to ſtand at a ſtay. Likewiſe to ſee the moon ſometimes to riſe and ſet not above a quarter of an hour's diſtance from her riſing or ſetting the precedent night, and at another time ſhe will be an hour and an half diſtance of time from her riſing or ſetting the precedent night. To ſee her ſometimes full, at other times gibboſe, after that horned, then again wholly to diſappear, ſometimes to be eclipſed in part, at other times totally eclipſed: Theſe appearances are very ſtrange and unaccountable to moſt people; but to give my fair reader ſome inſight into theſe myſteries, I ſhall endeavour to explain the motions of theſe two great lamps of heaven, and that by an inſtrument very familiar to the female ſex; I mean by the rim of an ordinary ſpinning-wheel.

Suppoſe then the outward or larger circle in the following figure, to be the farther ſide or edge of the wheel's rim; the inward or leaſt circle, the hither edge thereof: Suppoſe the middle circle to be a line drawn round the middle of it, or

else if you please the wheelstring tied close quite round the middle of the rim: and tho' these three circles are in the figure one bigger than another, because it could not be drawn otherwise upon paper, yet you must imagine them all equal, and that this is the upper or outside of the rim. (As for the pricked circle we shall consider that presently.)

Now let us suppose a fly was in the middle and top of the rim at (*a*,) and it run with a regular and even motion towards (*b*, *c*, *d*, *e*, *f*,) and so on till it run quite round the rim, in just the space of a minute. Now if while, at the same time, the fly at (*a*) begins its motion towards (*b*, *c*, *d*, &c.) you turn the wheel about the contrary way just four times in a minute, namely, towards (*h*, *g*, *f*, *&c.*) as you do in spinning. It then plainly follows, that the fly will go about once whilst the wheel runs the other way four times, so that when the rim is turned once about, the fly will be advanced one quarter of the rim and be at (*d*,) when the rim has been turned twice about, the fly will be half way at (*e*,) when thrice she will be at (*f*,) when four times they meet again exactly at (*a*).

Again, if when the fly began to move at (*a*) and go to the left-hand, you began at the same time to move the wheel-rim towards the right-hand or contrary way: And instead of turning it about four times, you had turned it twelve times about in the same time as the fly had gone about once. (It matters not whether it be in a minute, or hour, or day, or month, or any other time, provided it be the same time exactly, that the fly moves once about, the rim moves twelve times about the contrary way.) Upon this supposition, the fly, at the end of the first turning about of the rim, will be advanced to (*b*), a twelfth part of the circumference; at the end of the second turning about, it would be advanced to (*c*), another twelfth part; at the end of the third revolution, the fly would be advanced to (*d*), a third twelfth part, or quarter of the circle; and so likewise at the end of six revolutions of the wheel, the fly would be advanced to (*e*), half way, and at the end of twelve returns it would come to (*a*) again; the fly constantly and perpetually advancing in its slow motion one way, as the wheel did its swifter motion the other

other way. And the like you may conceive if the wheel made 30, 50, 100, 365, 500, or any other number of revolutions at the ſame time as the fly did one, it would neceſſarily fall out, that at the end of that reſpective number, the fly would come to its place again, from whence it firſt ſet out, and it matters not whether it began to move at (*a*), or at any other place at *b*, *c*, *e*, &c.

Let us once more ſuppoſe another wheelſtring ty'd about the rim of the wheel, the upper part at ♋ to touch the edge of the rim at the ſide next to you, the under part of the wheelſtring to touch the edge of the rim fartheſt from you at ♑, and then it would croſs the wheelſtring in the middle of the rim juſt half way between top and bottom on each ſide at (*d*) and (*f*,) (or which is all one at ♎ and ♈.) And now if you ſuppoſe the fly to begin to move about the ſecond wheelſtring, tied croſs-ways over the firſt repreſented by the prick'd circle from ♋ to ♌ ♍ ♎, and ſo round to ♋ again; and whilſt the fly moved once round, the wheel was turned the contrary way any number of times, (ſuppoſe 4 or 12 times) it would finiſh its revolutions juſt as is before declared, but with ſome difference to its former motion, as ſhall preſently appear.

JUST thus is the motion of the ſun, moon, and planets in the heavens. For the ſun and ſtars go by a * proper motion of their own from weſt to eaſt, as did the fly; and the whole heavens with ſun, moon, and ſtars, are carried the contrary way as the hand turned about the wheel; the ſun moves ſo ſlow, that while he goes once about in his own courſe, along the prick'd line one way, the heavens are carried about 365 times the contrary way, and then he comes to the ſame place again: But the moon is ſwifter in her motion, and runs round from weſt to eaſt, whilſt the whole heavens is whirled about 27 times and a quarter, or (which is all one) in 27 days and a quarter.

But from this motion of the ſun round the prick'd circle, ariſes ſeveral appearances carefully to be obſerv'd, becauſe it ſhews the reaſon of many of thoſe particulars I at firſt mentioned, viz. Let us ſuppoſe the ſun in ♋ going onward in his own ſlow motion towards ♌, and ſo on to ♍ ♎ ♏, &c. And the whole heavens carried about the contrary way once a day. It follows, that upon that day, which is about the † 11th of June, he is neareſt over our heads, and maketh the longeſt

 day

* Our author is not here to be underſtood to mean an abſolute or real motion; he means only the apparent motion ariſing from the real motion of the earth.

† Our author having written before the change of the ſtyle, all his times muſt be underſtood according to the old ſtyle, and will require 11 days added to adapt them to the new.

day with us, and then he rises and sets very much towards the north, and the line which he maketh in the heavens that day, is called the tropick of Cancer.

In a quarter of a year after, he will be got along the prick'd line to ♎, and then the days and nights are of equal length; and he rises just in the east and sets in the west, and the line which he maketh in the very midst of heaven, is called the equinoctial circle, and this happens about the 12th of September, [and just so it will be half a year after when he comes to ♈, which will be about the 10th of March.]

In a quarter of a year after, he is at ♎, he will come down by degrees to ♑, and then he is farthest from us, which happens about the 10th of December, and then the circle he seems to make in the heavens that day, is called the tropick of Capricorn, and then he rises and sets very much towards the south.

The prick'd line, in which the sun is supposed to pass, is called the ecliptick, because there can be no eclipse but the moon must be in or very near this circle; but the sun never goes out of it.

The whole breadth between the outward and inward circles (which two must be imagined equal) is called the zodiack, which is the only circle in the heavens that hath any breadth. The distance of any star from the ecliptick or prick'd circle, is called the star's latitude, (either north or south as it happens to be either north or south from the circle) and the distance of any star from the middle circle or equinoctial, is called its declination, (north or south as before.)

Again, when the sun is near the tropicks, as when he moves from ♊ to ♌, he moves just against the motion of heavens, and so is swiftest in his motion, and makes a greater speed toward's his journey's end; but then the length of the day and declination (or distance from the middle circle) is but little alter'd: But when he moves near the equinoctial, as from ♍ to ♏, then he runs obliquely or crosses the heaven, and then the days and declination increase or decrease evry considerably, but he moves but slowly towards his journey's end, because he crosses the heavens from one side of the middle to the other; and this is one of the reasons why from noon to noon is not exactly 24 hours, but sometimes more and sometimes less.

As the sun thus runs in a circle of his own from west to east, in one year, so doth the moon in a circle of her own in 27 days and a quarter the same way; and the moon's circle crosses the sun's circle in two points, just as the sun's circle crosses the equinoctial in ♈ and ♎: But the distance of the moon's circle, from the sun's, in the widest place, is not quite a fourth part the distance of the sun's circle from the equinoctial. But of this and of the various appearances of the moon, I have not now room to proceed.

AN

AN ECLIPSE of the ſun is cauſed by the moon, who is a dark body, being interpoſed or placed between the ſun and us, and this happens when the moon is near one of the points where her circle croſſes the ecliptick or ſun's circle. Thus, ſuppoſe the earth, whereon we live, to be in the middle of the precedent figure at ⊖, the ſun at (*f*) and the moon at ♈. Here becauſe the moon at ♈ interpoſes, it takes away the light of the ſun from us; ſuch will be the poſition of the ſun and moon upon May-day next year, 1706. It will begin to be darkened at 9 minutes after 8 in the morning, but at 17 minutes after 9 it will be the moſt darkened, when near 10 parts of 12 of the ſun's body will be obſcured, and he will appear like the firſt appearances of the new moon. This will be a great eclipſe; we had a greater in 1654, but a much greater in the year 1652, when the whole body of the ſun, within leſs than 16 minutes, was obſcured.

An eclipſe of the moon is cauſed by the ſun's being on one ſide the earth, and the moon on the other, (near the ecliptick) and the ſhadow of the earth falls upon the moon, (from whence ſhe hath her light.) As ſuppoſe the ſun in ♎, the earth in ⊖, the moon in (*f*), here the light of the ſun at ♎, falling upon the earth at ⊖, takes away the light of the moon at (*f*), who otherwiſe would reflect her light back upon us as at other times.

There are a great many admirable concluſions to be drawn from the conſideration of eclipſes, but more of that hereafter.

1706

Of the nature of an Eclipſe of the Sun, and of that great Eclipſe which will happen upon May-day this preſent year, with the exact time of its beginning, middle, and end; recommended to the obſervation of the curious.

THE mind of man hath a ſtrange propenſity, and eager thirſt after knowledge; nor will he ſpare for pains to gratifie his curioſity; he will traverſe mountains, valleys, woods and deſarts; he will plunge thorough the vaſt and raging ocean; he will penetrate into the bowels and caverns of the earth; nay, ſome will not ſtick to go to Hell beneath, to compaſs know-

ledge. But of all the objects of our thoughts, there is none more noble, or give a greater ſatisfaction to the mind, than the contemplation of the heavenly phenomena, the motions, periodical revolutions, appulſes, and other paſſions and effects of the fixed ſtars and planets. This made the poet cry out,

Ye ſacred muſes! with whoſe beauty fir'd,
My ſoul is raviſh'd, and my brain inſpir'd;
Give me the ways of wand'ring ſtars to know:
The depth of heav'n above, and earth below?
Why flowing tides prevail upon the main:
And in what dark receſs they ſhrink again?
What ſhakes the ſolid earth? what cauſe delays
The ſummer nights, and ſhortens winter days?
Teach me th' various labours of the moon,
And whence proceed th' eclipſes of the ſun?

DRYDEN.

Laſt year I gave you an account of the true motion of the ſun and moon about the heavens, with the various appearances cauſed thereby, ſuch as the increaſe and decreaſe of the days and nights, of their riſing and ſetting, and of their eclipſes; which things being rightly conceived, will be of great advantage towards the eaſie apprehending the following diſcourſe of the eclipſe of the ſun, which I now the rather undertake, becauſe there will be a very great eclipſe upon May-day next, the like not having been theſe fifty years paſt.

Now an eclipſe of the ſun is when the moon (who is a dark opake body) interpoſes or happens to come between the ſun and us, and ſhades or hides the light of the ſun from us, and this is ſometimes wholly, and then it is called a total eclipſe; and ſometimes but in part, and then it is called a partile eclipſe.

To conceive aright the true nature of the ſun's eclipſe, you may provide or imagine a large hoop of two yards diameter or wideſt breadth, cut off a third part from the reſt, and nail to the middle of this piece a ſtick of juſt a yard in length, that it may be like a croſs bow without a ſtring, and as you ſee in the lower part of figure 1. where *f*, *g*, *c*, *h*, *i*, repreſents the bow or third part of the hoop, and *K*, *c*, the ſtick. Suppoſe now you ſaw (or imagined you ſaw) a very fair rainbow painted on the clouds (as is alſo in figure 1. the upper part) take your hoop, and holding the end of the ſtick at *K* to your eye, turn the hoop to the rainbow, and hold it ſo that the hoop may ſeem to cover the rainbow, and hide it from your ſight. Being thus fixed, turn the ſtick (to which the hoop is faſtened) a little, that the hoop may croſs, or ſeem to croſs, the rainbow, the half *f*, *g*, *c*, being above it, and *c*, *h*, *i*, below it, as you may ſee in figure 2. where *a*, *b*, *c*, *d*, *e*, repreſents again the rainbow, and *f*, *g*, *c*, *h*, *i*, the hoop, and ⊖ at *K* repreſents the eye, (but here the ſtick affixed to the hoop is wanting.)

Now

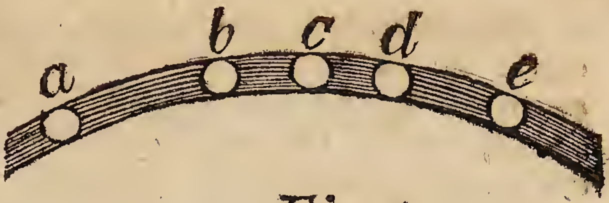
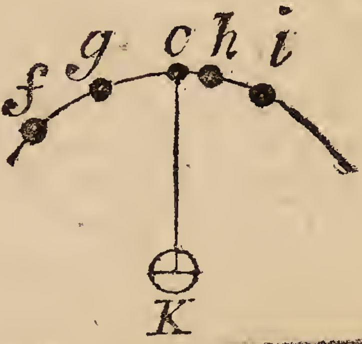


Fig. 1



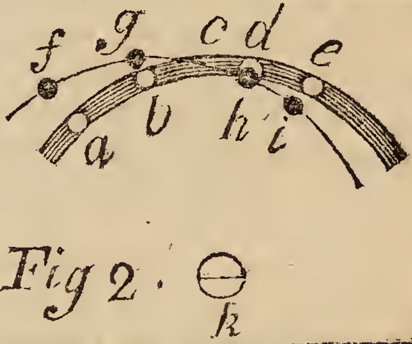


Fig 2.

Fig 3

Now if you join, or ſuppoſe to join, the other part of the hoop to this, to compleat the circle, and if you imagine the rainbow to be compleatly round, and about 400 yards diſtance every way from your eye, this will repreſent to your fancy pretty near the true paths or circles wherein the ſun or moon move; and alſo the proportions that their diſtances bear to one another.

For 1. The place of your eye at *K*, in either figure, repreſents ⊖ the earth you ſtand on. 2. The hoop repreſents the circle or path the moon moves in, who compleats her whole round from weſt to eaſt in about *29 days and a half. (See the laſt year's Diary.) 3. The rainbow repreſents the path of the ſun, being likewiſe a vaſt circle encompaſſing both the earth and circle of the moon, but a great way beyond it every way, and he moves round his circle once in a year. 4. The circle of the moon is not juſt under that of the ſun, but croſſeth it, as you muſt ſuppoſe it to do in fig. 1. and as it plainly appears in fig. 2. This place of

croſſing

* This is the Synodical month, or time between one lunation and another, and is 2 days and a quarter longer than the periodical month mentioned in the laſt year, page 3; this exceſs is cauſed by the motion of the earth (and moon) almoſt a whole ſign during the time of the periodical month, and the moon muſt continue to revolve for this additional time to bring her to a conjunction again.

croſſing is called the node, or dragon's head. Now had the circle in the figures been compleatly round, it would croſs again on the other ſide, which is called the other node, or dragon's tail; the angle it makes at the croſſing *f*, *c*, *a*, or *e*, *c*, *i*, fig. 2. is about 5 degrees.

Theſe things being rightly conceived, it follows:

1. If the circle of the moon had been juſt under the circle of the ſun, then at every conjunction, or new moon, there would be an eclipſe of the ſun, (and at every oppoſition, or full moon, there would be an eclipſe of the moon.)

2. But the circle of the moon croſſing that of the ſun, it follows there can be no eclipſe of the ſun, but when the moon is in or near her nodes, or places of croſſing, as you may plainly perceive by the figures. For ſuppoſe the moon in *f*, (in either fig.) the ſun in *a*, and the eye at ⊖ (or *K*,) here the moon is above the ſun, or higher than he, and therefore cannot hinder its light from us: if the moon had been at *i*, and the ſun at *e*, the ſame thing would happen, for then the moon is lower than the ſun, and ſo eclipſes him not: if the moon meets the ſun when ſhe is near her node, ſuppoſe at *g*, and the ſun at *b*, here ſhe paſſeth but a little above him, and ſo he eſcapes an eclipſe. But if when the moon was at *h*, the ſun was at *d*, here the moon would paſs between the ſun and ⊖, and appear half eclipſed; but if the moon was in *c*, the very point where her circle croſſes that of the ſun, and ſuppoſe the ſun at the ſame time to be at *c* alſo, then would the ſun be totally eclipſed.

From whence it is plain, that whenever there is a conjunction, (or meeting of the ſun and moon, (if it comes within the bounds of an eclipſe) then earer the moon is to her node, the greater will be the eclipſe of the ſun, and the farther ſhe is from it, the ſmaller will be the eclipſe; but when ſhe is ſo far from her node, or place where the circle croſſes, that half the apparent breadth of the ſun, and half the breadth of the moon will not reach to touch one another, then there will be no eclipſe for that conjunction; but if the conjunction be when the moon is a great way farther from her node, (as it moſtly happens) then moſt certainly there can be no eclipſe for that time.

Upon May-day next, the ſun, 'tis true, will not be totally eclipſed, but the centers of the ſun and moon will be but 5 minutes, very near, diſtance aſunder, and will be the greateſt eclipſe that hath happened theſe 50 or 60 years in our iſland; the time of the beginning, middle, and end thereof, I will give you from the calculation of one of the greateſt aſtronomers of this, or perhaps of all former ages, as alſo the parts of the globe the ſhadow will paſs over. (See fig. 3.)

The middle time of the eclipſe of the ſun, that happens

May

May the firſt, 1706, will be in the meridian of London at 9 ho. 42 min. in the morning.*

The viſible beginning of the eclipſe at London at 8 ho. 23 min.

The end at 10 ho. 37 min. and an half. At 9 ho. 30 min. about the middle of the eclipſe, the diſtance of the centers of the ſun and moon will be 5 minutes very near, and ſo will be of almoſt 10 digits and an half from the ſouth.

The ſhadow begins to enter the diſcus of the whole earth almoſt in the mid way between the Heſperiden and Caribee iſlands, then tending into the eaſt, leaves the Canary iſlands upon the left, and paſſes through the kingdom of Morocco. Hence coaſting the eaſtern ſhore of almoſt all Spain, it reaches Provence in France, near the port of Thoulon. Whence the ſhadow paſſing forward, after being ſpread through Piemont, and the country of Milan, deſcribes the borders of Bavaria and Auſtria, and then paſſing over Bohemia and Sileſia, overſhadows almoſt half Poland and Lithuania. Hence being carried by the regions of Moſcovy and Siberia, it ſlips into unknown Tartary, and laſtly above China it quits the earth, the ſun being there totally obſcured in its ſetting. But where the centers of the ſun and moon fall in together, the darkneſs will be like that of night, and the ſtars will be viſible for the ſpace of the one four and twentieth part of an hour.

How to behold an eclipſe of the Sun without hurt to the eyes. By Mr Pond.

TAKE a burning glaſs, ſuch as men uſe to light tobacco with in the ſun; or a ſpectacle glaſs that is thick in the middle, ſuch as is for the eldeſt ſight, and hold this glaſs in the ſun as if you would burn through it a paſteboard, or white paper book, or ſuch-like; draw the glaſs from the board or book twice as far as you do to burn with it: ſo by direct holding it nearer or farther, as you ſhall ſee beſt, you may behold upon your board, paper, or book, the round body of the ſun, and how the moon paſſeth between the glaſs and the ſun, during the whole eclipſe.

This may'ſt thou practice before the time of an eclipſe, wherein thou ſhalt diſcern any cloud paſſing under the ſun; or by another putting or holding a bullet or his finger's end betwixt the ſun and the glaſs, at ſuch time (the ſun ſhining) as thou holdeſt the glaſs, as before thou art taught.

I ſhall

* Theſe times are a few minutes different from thoſe given by the author laſt year, page 5. The obſerved times I ſhall give afterwards along with the other eclipſes.

I ſhall in my next give an account of the eclipſe of the moon, and of ſeveral admirable concluſions that are to be drawn from the conſideration of the eclipſes of both the great luminaries.

1707

Of the Phaſes and Eclipſes of the Moon.

HAVING in my laſt given you an account of the nature of an eclipſe of the ſun, as alſo of that great eclipſe on May-day, it was my intentions to have been very nice in the obſervation of it, by caſting its ſpecies upon paper by a teleſcope, and by ſix concentric circles equidiſtant from their center, to obſerve the digits eclipſed from time to time, and to have corrected the clock by calculation from the ſun's altitude, and to have inſerted my obſervations in this place; but the unfavourableneſs of the weather ſpoiled all my deſigns: however ſometime thro' the clouds the eclipſe was perceived, and, as near as could be gheſſed, at the very ſame time, and in the ſame appearance exactly as was there ſet down, and as by the figure of it was repreſented; the ſame ſide being enlightened, and the ſun appearing not much unlike a new moon of 3 or 4 days old; and this was all the obſervation I was able to make.

I come now, according to my promiſe, to ſpeak of the nature of an eclipſe of the moon, and of ſeveral obſervations and uſeful inferences, to be drawn from the eclipſes of the luminaries.

Now an eclipſe of the moon (as I have already ſhewn in my Diary for 1705) is cauſed by the earth's interpoſing or happening to be exactly in a right line between the ſun and moon, by reaſon whereof the light of the moon is obſcured by the ſhadow of the earth.

To conceive this aright, if you imagine (or actually put) a lamp or candle on one ſide of the room, (ſuppoſe five foot high from the floor;) and a looking-glaſs on the other ſide of the room, (five foot high alſo from the floor;) and if a fine thread was tied and ſtretched out ſtreight (or if you imagined a right line extended) from the middle of the looking-glaſs to the flame of the lamp, overthwart the room; then if you ſtand in the middle of the room, half a yard (more or leſs) on either ſide the extended thread, (or imaginary line) and looking towards the glaſs, you may plainly ſee the light of the lamp reflected back to your eye, (or to ſpeak as the common people conceive it, you may ſee the candle in the glaſs.)

glaſs.) And the like will happen if you place your eye ſome diſtance either above or below the line.

But if you put your eye or head juſt between the lamp and the glaſs, (where the line or thread is) then will your eye or head caſt a ſhadow upon the glaſs ſo that it cannot reflect back the light, (or to ſpeak with the vulgar, it will ſtop the light ſo that it cannot ſhine on the glaſs.) [And the ſame appearances would happen if the eye remained fixed to the ſtring in the middle, and the candle was lifted up and down.]

Not much unlike this is an eclipſe of the moon, for the moon hath no light of her own, but the ſun ſhining on her, ſhe reflects back his light, as the glaſs reflects back the light of the candle or lamp; but when the earth happens to come juſt between, then it hinders the light of the ſun from ſhining upon the moon, or to ſpeak more properly, the ſhadow of the earth falls upon the moon and eclipſeth her.

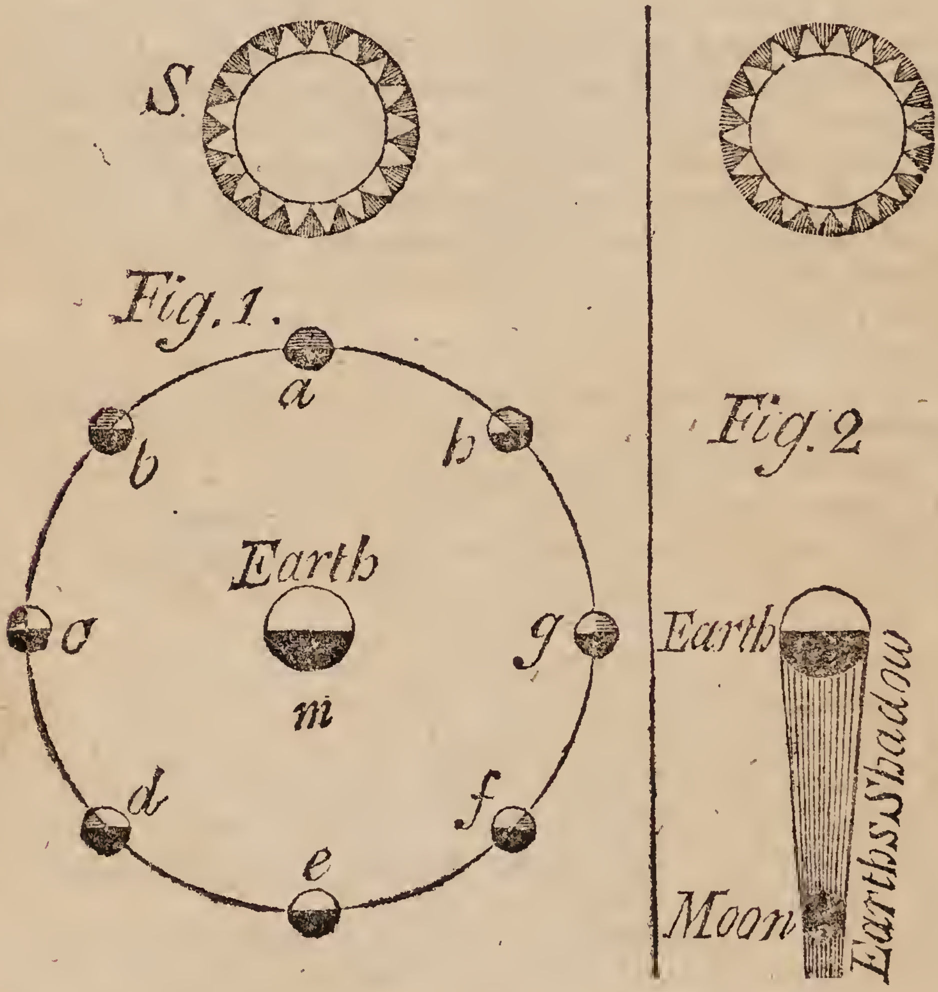
But to make this as plain as poſſible (and withal to account for the various phaſes of the moon, why ſhe appears round, gibbous, half-round, horned, and ſometimes not at all:) Suppoſe inſtead of a plain looking-glaſs you took a glaſs globe, and having it ſilvered withinſide, to make it a globular looking-glaſs. Place this, inſtead of the other, oppoſite to the lamp or candle: ſuppoſe then in figure 1. the ſun (*S*) repreſented the lamp, and the little circle (*e*) repreſented the globe looking-glaſs, and that your eye was placed ſomewhere between both, ſuppoſe at (*m*.) Now looking towards (*e*,) (if the eye was either higher or lower, or on the one ſide or other of the imaginary line between them) then would the light fall upon (*e*) and reflect back upon (*m*) and half the globe would be enlightened. But if the eye be exactly in the middle between them, then would the eye ſhade the glaſs (as in fig. 2.) and ſo darken it. That is, it ſtops the light from ſhining on the glaſs, and ſo it cannot reflect any back. (Or as I ſaid before, if the eye and glaſs remain fixed, and the light or lamp moved up and down, the ſame appearances would enſue.) And juſt after this manner, is an eclipſe of the moon: the ſun being on one ſide the earth (*S*) and the moon on the other (*e*): then if the earth doth not happen to be in the middle, as it for the moſt part falls out, (the reaſon whereof is ſhewn at large in the laſt year's Diary) then there is a full moon to us that live upon the earth, and no eclipſe; but if the earth happen to be juſt between them, as many times it doth, then there muſt needs be an eclipſe of the moon (as in fig. 2.)

From the conſideration of what hath been here ſaid, and viewing with ſome attention the firſt figure following, may the various phaſes or appearances of the moon be eaſily apprehended.

For

For the globe glaſs at (*e*) being round the light at (*S*) caſts its beams, or ſhines upon that half oppoſite to it; for it muſt needs ſhine upon half, nor can it ſhine either upon more or leſs than half, but always upon that half that is juſt facing the light, the other half from the light being dark of conſequence: I ſay the light (*S*) caſting its beams upon (*e*) enlightens that half towards it, ſo to the eye that is in (*m*) directly backwards, the whole half is reflected back, and appears perfectly round in the edges.

But if you order an aſſiſtant to remove the lamp to (*f*), then part of the enlightened half to you at (*m*) is turned from you, and you can ſee but three parts of it, and one quarter of the dark'ned part becomes turned towards you. If the light is removed to (*g*) and then but one half, if to (*h*) but one quarter, and if to (*a*) then none at all of the enlightened half to you at (*m*) is to be ſeen, it being from you; and if it was removed ſtill on to (*b*, *c*, *d*, *e*,) the light would encreaſe to the eye placed at (*m*) as it did decreaſe before.



This being rightly conceived, if inſtead of the imaginary lamp at (*S*) you conceive it to be the ſun, and if for the globe-glaſs

glaſs at (*e*) you conceive it to be the moon, and for the eye at (*m*) you conceive it to be the earth you ſtand on, the very ſame appearances will happen, and conſequently the reaſon of the various appearances of the moon are, I hope, made very plain without any farther explication.

But to return from this digreſſion to the eclipſe. If the earth's ſhadow covers the moon but in part (more or leſs) it is called a partile Eclipſe, but if it cover it in the whole, it is called a total Eclipſe.

Such an Eclipſe will happen on the ſixth day of April next, the beginning will be a little before midnight, and will continue till half an hour after three next morning, as followeth.

April the 6th, 1707.

	ho.	min.	
The beginning of the eclipſe will be at	11	40	at night.
Beginning of total darkneſs —	12	45	
The middle of the eclipſe —	1	34	next morning.
End of total darkneſs — —	2	24	
End of the eclipſe — —	3	29	
Total duration will be — —	3	49	And thus much of this eclipſe.
Total darkneſs will continue —	1	39	

Obſervations on Eclipſes of both luminaries.

1. The ſun is very ſeldom, but the moon often totally eclipſed, yet in the whole, the eclipſes of the ſun are the more frequent of the two.

2. The beginning and end, and quantity eclipſed, of an eclipſe of the moon, is ſeen from all parts of the earth (where it is conſpicuous) at the ſame moment of time (altho' under diverſe meridians:) but in eclipſes of the ſun it is not ſo, being at the ſame moment of time ſeen leſs in one place than another, and laſting in ſome places ſhorter, in others longer, and in ſome none at all.

3. The beginning of an eclipſe of the ſun is on the weſtern part of his limb, which part is alſo firſt reſtored to light. But in an eclipſe of the moon, it begins and ends on the eaſtern limb.

4. Total eclipſes of the moon are made ſometimes in a longer time, at other times quickly: but total eclipſes of the ſun are all without delay.

5. The moon in total eclipſes is ſometimes quite loſt, but at other times it ſhines very plainly with a red colour, either in whole or in part.

The uſes of, or concluſions drawn from, Eclipſes.

1. The courſe of the moon would not truly be known without eclipſes, by reaſon of her parallax.

2. The ſun is both higher and greater than the moon.
3. The earth is greater than the moon, but leſs than the ſun.
4. Both ſun and moon are ſpherical, unequally diſtant from the earth.
5. The ſun is the fountain of all light, but the moon is but a borrowed light from the ſun.
6. From eclipſes are found the difference of meridians or longitude of places.
7. From eclipſes of the ſun and moon, a reaſon is found of meaſuring their diſtances from the earth, as alſo of the magnitude and proportion that the ſun, moon, and earth have between themſelves; which otherwiſe may ſeem impoſſible.

By theſe wings it is the mind of man flies up into the heavenly theatre, and by theſe charms (as the poet ſaith) draws down the ſun and moon from heaven to earth.

1708.

Of the Ptolemaick Syſtem of the Univerſe.

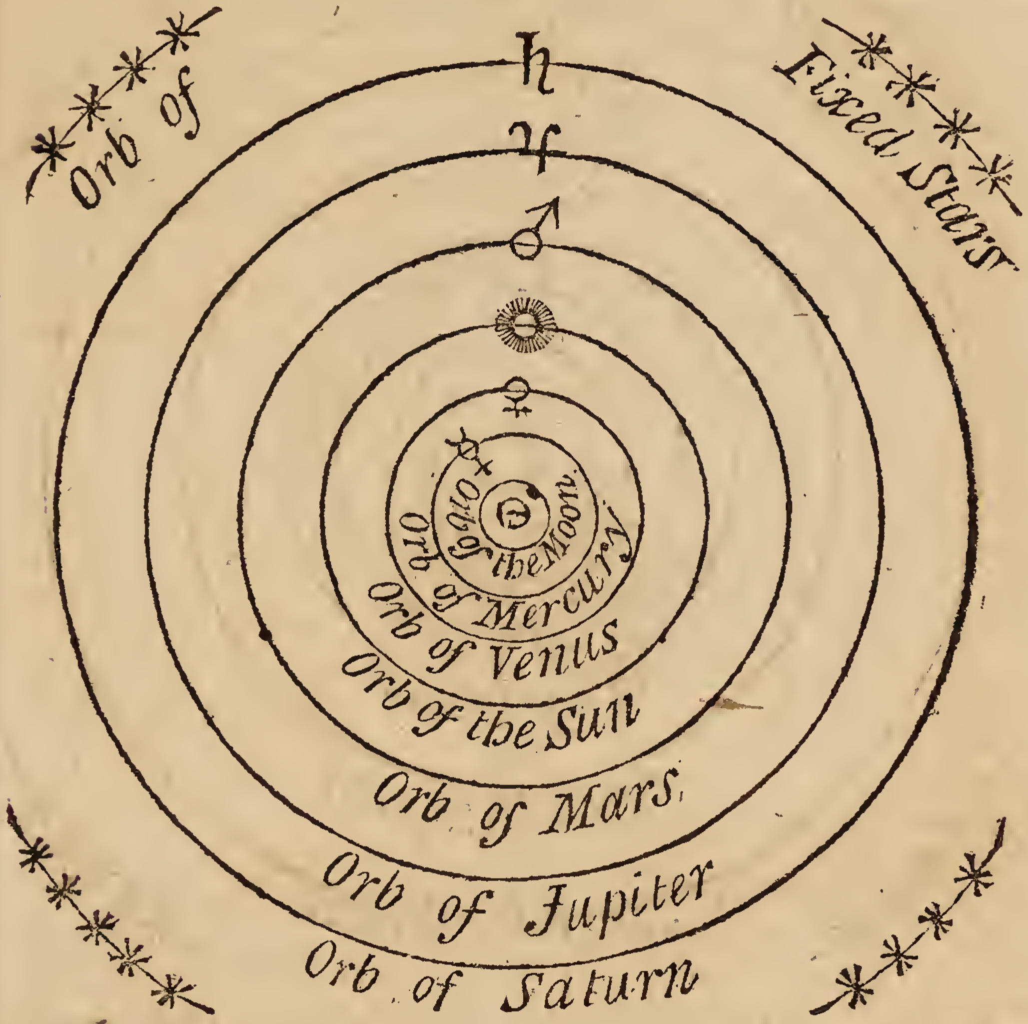
HAVING in my former Diaries explained the motions of the ſun and moon, as alſo the nature of their eclipſes, with the reaſon why the moon appears in ſo many various ſhapes in the ſpace of one revolution; I come now to ſpeak of the other five planets, viz. Saturn, Jupiter, Mars, Venus, and Mercury: but before I proceed it will not be amiſs to explain the ſyſtem of the univerſe.

There are various opinions among the learned concerning this difficulty, but the moſt prevailing are theſe two, namely, the Ptolemaick, and the Copernican, both which I ſhall now explain.

Ptolemy, Ariſtotle, and others held, that the earth is the center of the univerſe, which remains fixed and immoveable, and the whole heavens, and fixed ſtars, move round her in this order. (See fig. 1. following)

The planet that moves in a circle or orbit, next above the earth, is the moon; next above her moves the planet Mercury; next above Mercury, at a greater diſtance ſtill from the earth, doth the planet Venus move; and ſtill in a higher orb moves the glorious ſun; the planet next above the ſun is Mars; and Jupiter moves ſtill in an orb or circle, extended every where beyond the orb of Mars: Laſtly, the fartheſt of all the planets from the earth is Saturn, and he moves in a larger

larger circle than them all. Above theſe planets, a vaſt diſtance, are the fixed ſtars, and above the fixed ſtars, is the primum mobile and emperial heaven. And this is the Ptolemaick hypotheſis.



Of the Copernican Syſtem of the Univerſe.

THE Copernican ſyſtem makes the ſun to be the center of the univerſe, (as in the following fig.) round which (in the order there ſeen) are the orbits of Mercury, then that of Venus, then that of the earth, with that of the moon about it; then thoſe of Mars, Jupiter, and Saturn, one above another, and about the two laſt the ſmall circles, that their attendants or ſatellites march in, of which more anon; and above all theſe the fixed ſtars, &c.

This is the order of the heavens, according to Plato, Ariſtarchus, Archimedes, and other ancients; and after it had been almoſt quite forgot for many ages it was revived by Copernicus, and is now almoſt univerſally received.

However, both theſe hypotheſes do equally ſolve the doctrine of the ſphere, the firſt being the moſt eaſy for beginners, but the latter the more rational.

But ſince theſe hypotheſes have been received in the world, the later aſtronomers have, by the help of the teleſcope, found out many ſurprizing appearances, which I ſhall ſet down more particularly in the order as they lie in the heavens, beginning with the uppermoſt, and ſo deſcending down to our earth.

And firſt for the fixed ſtars: that whitiſh band or zone, that encompaſſes the whole heavens, called the Milky-way, and of which the ancients could give no tolerable account, is found by the teleſcope to be no other than an heap of very ſmall ſtars, thickly ſet together; which by their great diſtance, ſmallneſs, and cloſeneſs, appear to the naked eye, as one united whitiſh cloud. In like manner the Pleiades, or Seven Stars, tho' (ſaith my author Mr Molyneux) ſcarce more than ſix appear, are found by an ordinary glaſs, to be nigh forty; and Dr Hooke, in his Micrographia, ſaith, that with a twelve-foot teleſcope he plainly diſcovered 78 in the ſame aſteriſm, of no leſs than 14 ſeveral magnitudes, the biggeſt whereof

whereof is not accounted greater than one of the third magnitude. And in the single constellation of Orion, the telescope discovers more stars, than the naked eye can number, in all the heavens; and there is scarce any corner of the heavens so dark but the telescope being turned towards it, descries multitudes of glittering spangles therein. On this account the seed of Abraham, that was to be made numerous as the stars in the firmament, may yet (for ought we know) admit of propagation thro' many future generations, before it comes up to its limits.

From the fixed stars let us contract our prospect, and in a vast, long, and almost immense course homewards, we first meet with Saturn. By his slow motion he takes state upon him (being near 30 years in walking round the heavens) as carrying about him something more weighty than ordinary. But the short sight perceives nothing thereof, and sees nothing but a plain round globe, all his equipage and attendants are hid from our view, till survey'd more closely with the telescope, and then behold a mighty ring, parallel to the equator, bright as the planet's own face, encompassing round his body: but this is not all his equipage, for besides this throne of light, this majestick planet is constantly attended by a guard of five satellites or moons, that follow his motion, and dance round him continually in a circle.

Jupiter next presents himself, less encumbred than Saturn, yet not wanting a courtly train; for tho' his guards are but four in number, yet their size and brightness shew their strength, and their quick motion round him shews their diligence.

Galileo (who invented the telescope) was certainly the first inhabitant of this globe that ever saw them, and how strangely was he surprized, and struck with wonder, to see four little moons dancing round Jupiter, that from their first creation, to that lucky moment, had never struck the eye of any mortal inhabitant of this globe before. Were these then made for the use of poor man, from whose knowledge these were concealed for 5000 years together? Vain man! that thus presumest to confine the designs of the Almighty to miserable dust and ashes, when his infinite power can make millions of intelligent beings, to serve and praise him.

Besides these four little moons about Jupiter, the telescope discovers that there are about his body several brighter and darker parts like broad belts or zones, almost parallel to the ecliptic; as also a spot found in him, by which 'tis manifest that Jupiter turns round his own axis in the space of about 10 hours. A very strong argument to prove that our earth may do so likewise, since Jupiter who is so considerably bigger than the earth, has a motion much more quick than ours in 24 hours. He moves about the heavens in about 12 years.

Mars offers himſelf next, who truſting in his own ſtrength is attended by no guards; he compleats his circle in 687 days; but the prying teleſcope diſcovers in his face, ſcars, ſpots, and ruggedneſs, by which the ingenious Caſſini has determined, that he turns on his own axis, once in about 24 hours and three quarters. But however furious his beams are, he is beholden for them to the great fountain of light, and heat, the ſun, which is plainly viſible, in that, when he is in his quadratures with the ſun, and in his perigæon, he may be ſeen almoſt biſected, and to increaſe and decreaſe in light as our moon (but never ſo much as to be horned as the other inferiors.)

The glorious Sun doth next preſent itſelf, in whoſe bright face we can hardly expect to find dark ſpots; yet ſuch there are, and frequent too.

Scheinerus has publiſh'd a large book in folio, of nothing elſe: the only diſcovery that has been made by theſe ſpots, is, that the ſun turns round about his own axis in the ſpace of 25 days and a quarter. Formerly one ſhould ſeldom ſee the ſun's face (no more than now our brighter beauties here below) free from one or more black patches, but now (as if they were grown out of faſhion) he ſeldom wears any, one in five or ſeven years hardly appearing; as if now he put them on, more of neceſſity to cover an odd pimple, that may otherwiſe disfigure his countenance, than to adorn his face: how far the fair ſex ſhould follow his example, I dare not venture to determine; but from them we naturally fall to Venus.

Venus, the brighteſt planet in the heavens, ſhe fears not ſometimes, even at noon-day, to diſplay her beauty, and in this armour repoſing an entire confidence, performs her courſe alone, and free from all other attendants, in 225 days.

Mercury's wit and quickneſs ſecures him; therefore he has no train, but generally ſhelters himſelf under the beams of his potent lord, the ſun, and performs his circuit round him in about 88 days. But both theſe inferior planets are found by the teleſcope to increaſe and decreaſe as our moon; for ſometimes they appear horned, ſometimes half enlighten'd, ſometimes gibbous, and ſometimes full, even on, or nigh this conjunction with the ſun: by which it is manifeſt, the Ptole maick hypotheſis is falſe, whatever hypotheſis is true.

And thus at laſt are we arrived at home to contemplate our neighbour the Moon, which we may call our own; for as the ſatellites about Saturn and Jupiter move about them, ſo moves the moon as a ſatellite about us. By the teleſcope we diſtinguiſh in the moon's countenance, an admirable difference of parts, both for ſhape and colour; the greater parts reſembling our ſeas, lakes, rivers, iſlands, peninſulas, and continents; the leſſer ſpots reſembling mountains, hills, and valleys: but whether the moon is inhabited or not ſtill ad-

mits

mits of various diſputes, tho' believed by the moſt ingenious ſo to be.

1709

Of the Nature and Motion of Comets.

COMETS, or blazing ſtars, were by the ancients taken to be nothing elſe but vapours and exhalations, or ſuch-like diſſipable matter: But by our late aſtronomers (and that more truly) they are found to be a ſpecies of planets, that revolve about the ſun in eliptical orbits, whoſe periodical times and motions, are as conſtant, certain, and regular, as thoſe of the planets. The eliptical orbits are ſo very oblong and excentrical, that they are but little different from parabola's, and may be conſidered at ſuch.

Alſo the inclination of the plains of the planets, are at moſt not above five or ſix degrees different from the plain of the ecliptick, yet the plains of comets are exceeding various, and are at all imaginable angles of inclination with one another, and with that of the ecliptick.

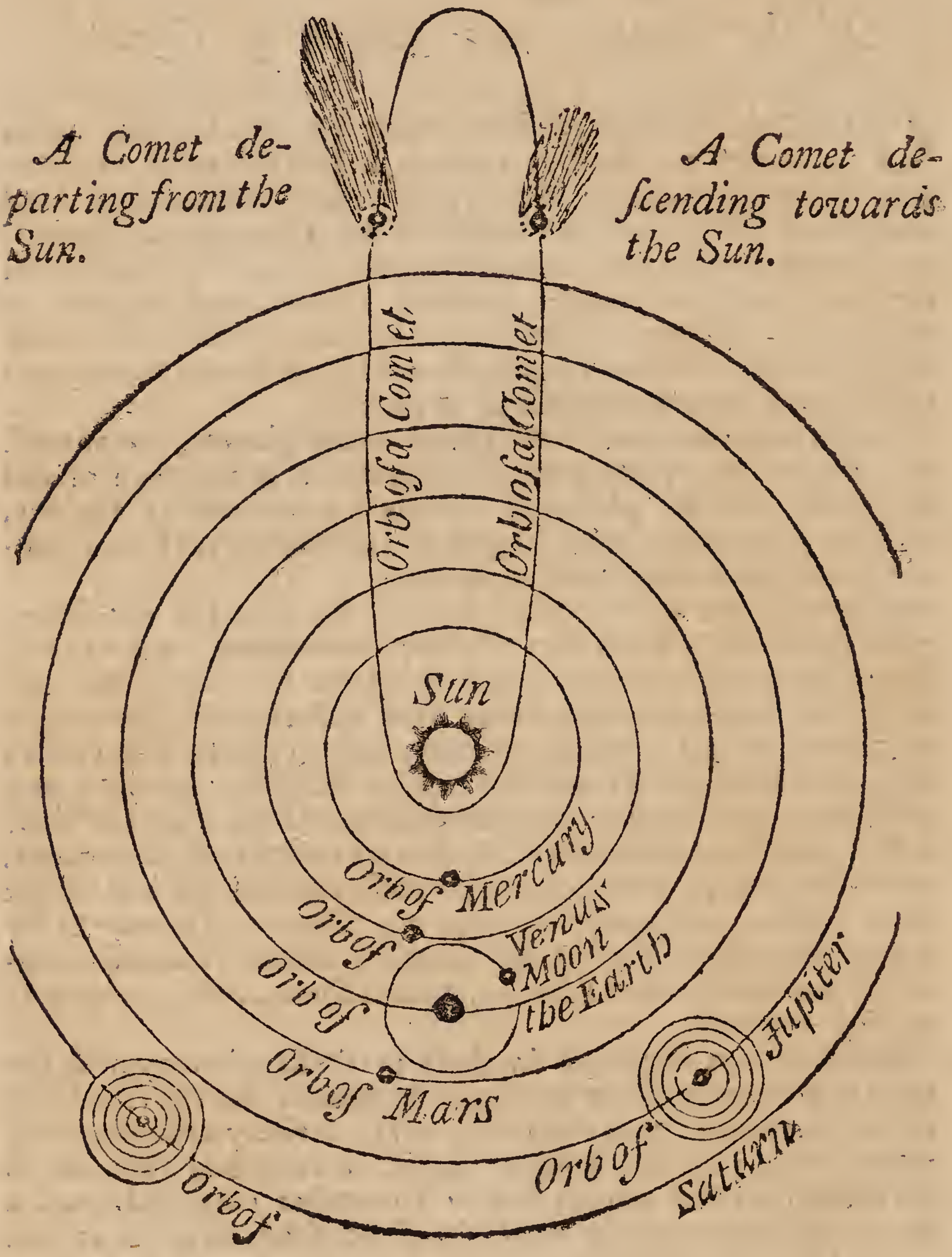
Likewiſe the courſe of comets in the orbits is not determined one way, (as is that of the planets from weſt to eaſt) but indifferently; ſome of them move one way and ſome another: for ſometimes they move from eaſt to weſt; ſometimes from weſt to eaſt; ſometimes from north to ſouth; other times from ſouth to north; and ſometimes obliquely between any of theſe ways, according as the ſituation of the plains of their orbits, and the direction of their courſes together do determine.

It is obſerved, that comets in their deſcent to, and aſcent from the ſun, paſs quite through the planetary ſyſtem, as by the enſuing figure may plainly appear; which effectually confutes the notion of ſolid orbs, which ſome of the ancients ſo fondly conceited.

Some comets approach in their perihelia, ſo very near the ſun, that they muſt be prodigiouſly heated thereby, and this to ſuch a degree, that they may not be intirely cold for many years. Thus the laſt famous comet in 1680 and 1681, at its perihelion on the eighth day of December 1680, ſuſteined a degree of heat twenty eight thouſand times as great as that we feel with us in ſummer; or about two thouſand times as intenſe as is that of a red hot iron. So that by Sir Iſaac Newton's calculation, if that comet was as big as our earth, as denſe

denſe and ſolid as iron, and were throughout equally heated to the forementioned degree, 'twould ſcarce, in our air, be fully cooled in fifty thouſand years: ſo that it cannot conſiſt of vapours and exhalations as the ancients thought.

The ſolar ſyſtem, with the manner of a comet's departure from, and deſcending towards the Sun.



The ingenious Captain Hally ſaith, that the comet which appeared in 1682, will probably appear again, in 1758, being 50 years yet to come. But by a careful review of the hiſtory of comets, I have, with no ſmall pains, endeavoured to find out the times of the revolutions of ſeveral of them: and if the hiſtories I have peruſed are true, there will be ſeveral appearances of them, before that time; nay, I am almoſt perſwaded

That one (or more) comet or blazing ſtar, is now near at hand, or ſome ſtrange appearance in the heavens.*

1710

Of the Fixed Stars.

HAVING in my former Diaries, given an account of the ſun, moon, and other planets; of the various ſyſtems of the heavens, of the wonderful diſcoveries made by the teleſcope, of the ſyſtems of the comets, and of the paſſions and affections of the wandring ſtars, I come now to treat of the fixed ſtars, and of their various magnitudes, diſtances, number, and conſtellations.

All thoſe glittering ſtars (except ſeven) which we ſee beſpangling the firmament of heaven, and encircling the terreſtrial orb at unmeaſurable diſtances, are called fixed ſtars; for tho' they ſeem to roll about the earth in four and twenty hours, yet they keep the ſame diſtances from one another, and from the ecliptick, they riſe and ſet upon the ſame points of the horizon, and paſs the meridian at the ſame altitude, and are as if they were ſo many lucid points fixed to the celeſtial

* The above diſcourſe and prediction of our author ſeems to have had very ſufficient grounds for a foundation; for, when he had perceived from *Doctor Hally's Aſtronomiæ Cometicæ Synopſis*, or otherwiſe, that at leaſt fourteen comets had been obſerved in different years throughout the preceding century, he needed no witchcraft to aſſert that *ſeveral* would appear during the next 50 years; and accordingly many comets appeared during that time (as we ſhall remark in their reſpective years as they occur in courſe), and among the reſt Doctor Hally's anſwered very well according to his prediction. Our author however does not ſeem to have had the pleaſure of obſerving the accompliſhment of his prediction, as he died in 1713 or 1714, and I find no accounts of any more comets before the year 1717.

leſtial firmament, for which reaſon they are called the fixed ſtars.

The number of them which appear to the naked eye, according to the ancient aſtronomers, are 1022. But ſince the teleſcope hath been invented, they are found to be innumerable.

Their diſtances from us are incredible, being according to the computation of our modern aſtronomers, ſo far off, that if from one of the biggeſt ſtars, (which are ſuppoſed to be the neareſt) a bullet was ſhot out of a cannon, and to continue its utmoſt ſwiftneſs till it arrived at our earth, it would be little leſs than ſeven hundred thouſand years in its journey, before it could reach us.

Their magnitudes are no leſs amazing, for according to Gallileus (whoſe account is much leſs than ſome others) the body of the leaſt ſtar is above nine hundred thouſand millions of times bigger than the globe of the earth.

But to wave at preſent theſe nice ſpeculations, and to come to particulars more obvious and certain: Let us ſuppoſe ourſelves in an open plain, in a curious clear and charming night, viewing the beſpangled heavens, and beholding the wondrous works of the Almighty; we cannot but obſerve ſtars of different bigneſs, and of different luſtre and glory. To diſtinguiſh theſe from one another, the ancients divided them into ſix degrees of bigneſs or magnitude: thoſe that you ſee the biggeſt and brighteſt of the whole firmament, they called ſtars of the firſt magnitude; thoſe that you ſee of the next inferior bigneſs and brightneſs, they called ſtars of the ſecond magnitude; thoſe of the next degree, ſtars of the third magnitude; and ſo they gradually decreaſed to the ſixth magnitude, which are the ſmalleſt ſtars of all: now to many of the moſt eminent ſtars, the ancients gave particular names, calling one Aldebaran, another Regulus, a third Rigel, a fourth Arcturus, a fifth Procyon, a ſixth Dubbe, and ſo of many others of divers magnitudes, giving names to about fifty ſtars in all.

To have deviſed names thus for every ſtar, would have been very troubleſome, if not impoſſible; to remedy this inconvenience therefore, they ſeparated the ſtars into divers parcels, ſome more and ſome leſs; and formed them by their imagination, into the ſhapes of men, women, birds, beaſts, and the like; which ſerved them to as good purpoſe, as if the appearance of thoſe ſhapes were viſible in the heavens; for by theſe images or imaginary creatures, they came to know and name the ſtars, as diſtinctly, as if they were called by particular names; and after they came to be more accurate in aſtronomical obſervations, they put down upon paper, the true bearing, diſtance, and magnitude of the ſtars, and actually drew about them the ſhapes as they before imagin'd

them

them in the heavens: and thus they parcelled out all the viſible ſtars into * 48 conſtellations or parcels, 12 whereof were in the middle of the heavens, encompaſſing it about like a girdle, which they called the 12 ſigns, (in which the 7 planets always move) 21 conſtellations or images they parcelled out towards the north part of the heavens, and 15 towards the ſouth, to which the modern aſtronomers have added 12 more in the ſouthern hemiſphere, unſeen by us.

But that my fair reader may the better apprehend my meaning, I ſhall deſcend to ſome particulars. Not far from the north pole, the ancients parcelled out 35 ſtars, whereof 7 are of the ſecond magnitude, 3 of the third, 8 of the fourth, 12 of the fifth, and 5 of the ſixth magnitude, and formed about them the ſhape of a bear, and called this conſtellation by the name of the Great Bear, (to diſtinguiſh it from another conſtellation of 10 ſtars, lying near theſe, called the Little Bear) which being put down upon paper, in their true and proportionate diſtances and magnitudes, as they are in the heavens, with the image drawn about it, will appear as in the figure *marked on the celeſtial globe.*

From which figure the ſtars in the heavens may be eaſily known, and diſtinguiſhed, the one from the other.

Thus there is the ſtar at the end of the tail of the great bear, the ſtar in the middle of its tail, and the ſtar in his rump, which has a diſtinct name given it, viz. Alioth, (as alſo hath that ſtar in his back called Dubbe); the lower ſtar in his hinder foot, and the ſtar in his mouth or under jaw; and ſo of the reſt, according to the places or parts of his body wherein they are poſited.

But theſe ſeven more eminent ſtars (all of the ſecond magnitude) are by ſeamen ſeparated from the reſt, and made a conſtellation by themſelves, called the Wain or Charles's Wain, whereof the two lower ſtars are the two wheels, the two ſtars above theſe are the waggon part, and the other three ſtars the three horſes (or oxen) to draw it; whereof one is the thill-horſe (or the filler) called Alioth, the middle-horſe, and the

* The number of conſtellations now in uſe are 77, viz. the 12 ſigns or conſtellations of the zodiac, 28 conſtellations on the north of it, and 37 on the ſouth. Many ſtragling or unformed ſtars having been reduced into conſtellations by modern aſtronomers.

The number of ſtars alſo now put upon the conſtellations are more in number than thoſe mentioned by our author in this diſcourſe, as I ſhall ſhew at the end of it.

In peruſing the deſcriptions of theſe conſtellations, the reader ought to have at hand a celeſtial globe; and comparing each conſtellation and ſtar there with its deſcription here, will impreſs a very juſt idea of its form, ſituation, &c.

the fore-horſe of the wain. The image, picture, or ſhape of this wain, you may eaſily form in your own imagination.

The fartheſt two ſtars from the end of the tail of the great bear are by our ſeamen called the guards; for by them they find the ſtar at the end of the tail of the little bear, called the pole ſtar: Thus, if you look upon theſe two ſtars in the heavens, and extend a line in your imagination from the one to the other, and ſo continue it in the heavens about five times the diſtance of thoſe two ſtars, you will meet with the pole ſtar of the ſecond magnitude; or the end of the tail of the little bear (of mighty import to the ſeamen) or by ſome called the fore-horſe of the little wain, from whence you will eaſily find the 7 ſtars of the little wain, being in the ſame ſhape as the greater wain. [But the ancients added 3 ſtars more to theſe 7, and formed the conſtellation into the ſhape of a little bear, as I ſaid before.

A little behind the tail of the great bear, are another parcel of ſtars, which the ancients drew into the image of a man, and called this conſtellation Bootes, or the driver of Charles's wain. He is alſo called Arctophylax, the keeper of the bear. There is another ſtar in the border of his garment, of the firſt magnitude, ſeveral times mentioned (with other ſtars and conſtellations) in the holy ſcriptures, namely, Job. 9. 9. Job 38. 32. and in Amos 5. 8. It is called Arcturus, which in the hebrew ſignifies a congregation or gathering together, ſuitable to the expreſſion in Job 38. 32. Canſt thou guide Arcturus with his ſons? that is, with all the other ſtars that make up that conſtellation.

Any of the ſtars of this conſtellation may be known as in the laſt; for I ſhould ſay, the ſtar between his hook and his head; that in his cheek; that in his girdle; the lowermoſt in his leg; the middlemoſt in his knee; the uppermoſt between Arcturus and that in his knee, &c. you can eaſily point them out, and know them as diſtinctly as if each of them had a particular name.

Another company of ſtars that encompaſs the pole of the ecliptick, and lie diſperſed in various places, the ancients formed into an image or conſtellation called the Dragon, wreathing and twiſting itſelf betwixt the two bears: It is a notable conſtellation, having ſtars in every one of the 12 ſigns, and the pole of the ecliptick is in the very middle of it. It hath one ſtar of the ſecond magnitude, being the laſt but two in the tail. Another ſtar is called Raſaben, being a bright ſtar in the head of the dragon, famous for that the ingenious Mr Robert Hooke, Fellow of the Royal Society, made uſe of this ſtar, to attempt the proof of the motion of the earth by obſervation, in 1674. Where he obſerved (as the Reverend Mr Flamſteed hath diverſe times ſince) a parallax of the

the earth's annual orb, which infallibly proves the motion of the earth to be true, according to the doctrine of Copernicus.* To give one inftance more:

Behind the neck of the dragon, the ancients formed another conftellation of ftars into the image of a fwan. The ftar near the tail is of the fecond magnitude, and is called aridef or arided; and near the ftar in its breaft a new ftar appeared in the year 1601, and after fome time difappeared. In the year 1658 it appeared again, and likewife in the year 1670, and fo it continued appearing and difappearing feveral times; it was a ftar of the third magnitude, and at this time wholly difappears.

The ftars in this (as in the other conftellations) are eafily known and diftinguifhed, if you obferve about what parts of the head, neck, breaft, wings, tail, &c. they are placed. What their magnitudes are, &c.

And thus you fee the method made ufe of by the ancients, to diftinguifh and name the greateft part of the vifible ftars in the firmament, by forming moft of them into images and conftellations.

There are fome few of the leffer ftars, which could not conveniently be brought into conftellations, which they called informes, or unformed ftars, fuch as the fix fmall ftars beneath the great bear; and the three ftars before its head, the two fmall ftars by the tail of the dragon, and divers others: yet thefe are alfo eafily known by their fituation, diftance from, or neighbourhood to the conftellations near which they are placed, or to fome parts of them.

I am perfwaded that nothing can be more diverting to the fair fex, than to be able to know and name the conftellations and ftars in the firmament, and to point them out to her fair companions in a ferene clear night; faying, (for inftance) "Look yonder, madam, that great ftar of the firft magnitude, " is called the bull's eye, that clufter of little ftars near it is " in the bull's neck, and called the pleiades; that ftar of the " fecond magnitude, is the end of his north horn; and that " of the third magnitude is the tip of his fouth horn. Look " yonder is the great warrior Orion. This conftellation is " men-

* Unfortunately for our author, and the great aftronomers whofe authorities he quotes, the change of place of the fixed ftars hath been difcovered fince by *Doctor Bradley*, to be owing to other caufes, viz. the aberration of the rays of light and the libration of the earth's axis. The parallax of the earth's orbit not amounting to one fecond, and is quite imperceptible to all inftruments.

But this miftake does not however invalidate the *Copernican* motion of the earth, that being fufficiently proved by other means.

"mentioned, with the pleiades and others, in the book of "Job, cap. 38. Thoſe three ſtars of the ſecond magnitude, "is called his girdle; and that ſtar of the firſt magnitude, "on this ſide it, is in his left ſhoulder; and that great ſtar of "the firſt magnitude, beyond his girdle, is in his right "foot, and is called rigel; thoſe three ſmall ſtars in a right "line, are in his ſword. Look yonder, farther ſouthward, in "a ſtreight line with Orion's girdle, is the moſt glittering "ſtar in the heavens, called ſirius; this ſtar, with 18 others, "make up a conſtellation called the great dog; this ſirius "being in his mouth, and that other towards the right hand "is in his left foot, &c." The knowledge of theſe particulars, I preſume, will be very entertaining to the ladies, all which I ſhall endeavour to ſhew in ſome of the ſucceeding Diaries.

1711

Of the Conſtellations of the Zodiack.

IN my laſt year's diary, I began my diſcourſe of the fixed ſtars; and therein ſhewed you, how the ancients (the better to know them) ſeparated them into divers parcels, called conſtellations; giving to ſome of them the names of men and women, as Cepheus, Orion, Caſſiopea, &c. to others the names of beaſts, birds, fiſhes, &c. as the lion, the bull, the eagle, the whale, &c. to others the names of inanimate beings; as the altar, the ſhip, the balance, &c. And the better to give my fair reader a juſt notion or idea of theſe conſtellations, I there ſhewed you, that there were 48 of theſe images or conſtellations reckoned among the ancients; namely, 12 in the middle of the heavens, 21 on the north ſide, and 15 on the ſouth ſide the ſame; all which I deſigned only as an introduction to the knowledge of the fixed ſtars. I ſhall now proceed to inſtruct my reader, not only in the knowledge of the names and ſhapes of the conſtellations, but alſo how to find them in the heavens, and to point out the moſt noted ſtars in the firmament.

I ſhall begin with the 12 images, that environ the whole heavens in the middle like a girdle or zone; for which reaſon they are called the 12 ſigns of the zodiack; and becauſe they are ſo often mentioned, and come frequently into uſe (more eſpecially becauſe the ſeven planets, or wandering ſtars, conſtantly move therein.) The ancients invented 12 characters or

or marks to repreſent them; not made at all adventures, but neatly contrived to know them thereby, and which are made uſe of at this day.

Theſe 12 images, conſtellations, or ſigns, are placed in the heavens in this order: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Piſces, and are placed in the heaven from weſt towards the eaſt, or (with us) from the right hand towards the left.

Thus, if I ſee Aries in the heavens, the next ſign Taurus, ſtands towards the left hand, or eaſterly of Aries, and the next ſign Gemini, ſtands more eaſterly, or on the left hand (to us) of Taurus, and ſo of all the reſt.

The firſt conſtellation, or ſign in the zodiack, is called Aries, or the Ram; and the character or mark the ancients made uſe of to know it, was two horns ſet upright, thus, ♈. This ſign conſiſts of nineteen ſmall ſtars, whereof that called the firſt ſtar of Aries is the moſt remarkable, becauſe from it many aſtronomical tables were formerly calculated; and from this ſtar Copernicus accompted the proceſſion of the equinoctial. About four hundred and ſeventy years before our Saviour's time, this ſtar was in the firſt ſcruple of Aries; but it is now in 29 degrees and 4 minutes of the ſame ſign; and about 1780 it will entirely leave Aries, and be got into the ſign Taurus. There is alſo the bright ſtar on the top of his head, the ſtar in the rump, &c. as I ſhewed you more fully in my laſt. (Over the ram is a ſmall conſtellation of three ſtars called the triangle, which I have here alſo remarked the better to find out Aries by.)

The next conſtellation of the zodiack is Taurus, the Bull, denoted by the ancients with a horned head of a bull, thus ♉. This image conſiſts of 48 ſtars, whereof one is of the firſt magnitude, called his ſouth eye; it is alſo called by the Arabians, aldebaran. Another in the tip of his north horn is of the ſecond magnitude, that of the third magnitude is the ſtar at the end of his ſouth horn, then the ſtar in the bend of his knee, &c. In this greater conſtellation, are included two ſmaller, one of five ſtars in his forehead, in form of the roman V called the Hyades, (whereof aldebaran is one of the top of the V). The other is a cluſter of ſtars in his neck, (commonly called the ſeven ſtars, and known to every boy in the ſtreets: called in the ſcripture (Job 9. 9.) the Pleiades. The other ſtars in this conſtellation are eaſily known, by the places they poſſeſs in the image, whether it be in his horns, legs, face, neck, &c. as I fully ſhewed you in the laſt year's Diary.

The third conſtellation in the zodiack is Gemini or the Twins; and is characterized by two boys embracing one another, thus, ♊.

 The

The fourth ſign, is Cancer or the Crab, and is known by a character of two oppoſite eyes and horns, thus, ♋ : This conſtellation hath none but ſmall ſtars only, two of them are of the third magnitude, that in the breaſt is called præſepe, much celebrated by the ancient poets; as are alſo the other two called the north and ſouth aſſelli.

* The fifth ſign in the zodiack is Leo or the Lion, which the ancients agreed to be deſigned or characterized by a lion's tail turned upright thus ♌, containing 43 ſtars, whereof 2 are of the firſt magnitude, viz. the lion's heart, called Regulus; and the lion's tail, called Cauda Leonis, and is a very fair ſtar. There are alſo in this image 2 ſtars of the ſecond magnitude; namely, one on the top of his loins, and the other in his neck; by which 4 ſtars all the reſt may be eaſily known.

The ſixth ſign is Virgo, or the Maid or Virgin, which is denoted by the folds or hems of a woman's garment in this manner ♍; of above 40 ſtars, and hath one conſiderable one of the firſt magnitude, called Spico Virginis, or vindemiator.

The ſeventh ſign in this circle is called Libra, or the ballance or pair of ſcales, which they have portraicted in the ſimilitude of a ballance in this manner, ♎ conſiſting of 14 ſtars, whereof 2 are of the ſecond magnitude, viz. one in the ſouthern-ſcale, called lanx meridionalis, and the other is ſometimes called bilanx.

† The eighth ſign is Scorpio, or the Scorpion, deſcribed by the knoted tail and ſting of a ſerpent thus, ♏ which hath one of the firſt magnitude, called Cor Scorpionis, or the Scorpion's Heart, and one of the ſecond magnitude in the head.

The ninth ſign is Sagittarius, or the Archer, which the ancients have noted with the portraicture of an arrow thus, ♐; called alſo the Centaur; it conſiſts of 30 ſtars, two whereof are of the ſecond magnitude, one in the knee of his right leg, and the other in the heel of the ſame leg. Between his two forefeet is placed another ſmall conſtellation called the Southren crown, (corona auſtrina.)

The tenth ſign is Capricorn, or the Goat, which antiquity noted with a goat's foot tied in a ſtring thus, ♑; conſiſting of twenty eight ſtars, but none of them either of the firſt or ſecond magnitude.

The eleventh ſign is Aquarius, or the Water-bearer; which the ancient aſtronomers have depictured by the waving of water thus ♒; having 42 ſtars in it, but none of any conſiderable magnitude.

The twelfth or laſt ſign of the zodiack is Piſces, or the Fiſhes, and this image is repreſented by two fiſhes bound together

* From the diary for 1712. † For 1713.

gether thus, ♓; which contains 36 ſtars, but none of them either of the firſt or ſecond magnitude*.

† As the ancients did neatly characterize the 12 ſigns, ſo likewiſe did they depict the 7 planets in like manner, which I ſhall now alſo ſhew you.

Saturn is depicted like an old man leaning upon a Staff, after this manner ♄.

Jupiter

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* Our author dying before he had compleated the deſcriptions of all the conſtellations, as he had promiſed and intended, I ſhall here ſupply the defect by ſubjoining the whole catalogue of conſtellations and number of ſtars upon each, as now generally uſed.

I. The twelve conſtellations in the zodiack, with their characters and number of ſtars, are thus :

		Stars			Stars.
1 Aries	♈	20	7 Libra	♎	20
2 Taurus	♉	53	8 Scorpio	♏	25
3 Gemini	♊	33	9 Sagitary	♐	22
4 Cancer	♋	31	10 Capricorn	♑	30
5 Leo	♌	45	11 Aquarius	♒	49
6 Virgo	♍	50	12 Piſces	♓	39
	Sum	232			185
					232

The ſtars in the zodiack are 417

II. The 28 northern conſtellations are

	Stars		Stars
1 Urſa minor	19	15 Perſeus	40
2 Urſa major	39	16 Auriga	27
3 Draco	37	17 Serpentarius	31
4 Cepheus	34	18 Serpens	18
5 Camelopardalus	28	19 Sagitta	8
6 Jordanus	31	20 Aquila	24
7 Bootes	38	21 Antinous	12
8 Corona Borealis	9	22 Delphinus	11
9 Hercules	34	23 Equiculus	4
10 Lyra	17	24 Pegaſus	25
11 Tygris	38	25 Andromeda	34
12 Cygnus	29	26 Triangulum	5
13 Sceptrum	17	27 Irinus	7
14 Caſſiopeia	30	28 Coma Berenices	13
	400		259
			400

Northern Stars 659

† From the diary for 1711.

III. The

Jupiter is repreſented like a king bearing a ſcepter thus ♃.
Mars is noted by a war-like engine, thus ♂.
The Sun by a round figure, thus ☉: and ſometimes by a figure beamed about after this manner ✵.
Venus is figured in the ſhape of a young maid, thus ♀.
For Mercury they drew a young man with wings in his cap, after this faſhion ☿.
And laſtly, for the Moon, they marked, it horned, thus ☽ or thus ☾, as ſhe appears in her quarters.

The author, at the bottoms of the almanack pages for 1710, thus deſcribes the conſtellations, in verſe.

The northern conſtellations.

Within the glorious firmament, the ſky,
Doth eight and forty conſtellations lie.

First

III. The 37 ſouthern conſtellations are

		Stars.			Stars.
1	Cetus	28	20	Phœnix	13
2	Orion	60	21	Indus	12
3	Eridanus	36	22	Pavo	14
4	Lepus	13	23	Apus	11
5	Canis major	19	24	Muſca	4
6	Columba	11	25	Cameleon	10
7	Canicula	11	26	Tringulum auſtrale	5
8	Monoceros	23	27	Piſcis volans	7
9	Navis	46	28	Dorado	4
10	Hydra	29	29	Nubes	3
11	Crater	11	30	Toucan	8
12	Corvus	9	31	Hydrus	10
13	Crux	4	32	Nubicula	3
14	Centaurus	35	33	Rhomboides	4
15	Lupus	21	34	Royal Oak	10
16	Ara	7	35	Lynx	19
17	Corona auſtralis	13	36	Vertagus	23
18	Piſcis auſtralis	17	37	Unicorn	19
19	Grus	13			
					179
		406			406

Southern ſtars 485
Northern ſtars 659
Zodiacal ſtars 417

Stars in all 1661

But theſe are not to be underſtood as the number of all the perceptable ſtars, but only of thoſe now put upon celeſtial globes. The britiſh catalogue contains 3001 ſtars, though it conſiſts of fewer conſtellations than the above.

First near unto the cold and northern pole,
The dragon lurks, and both the bears do rowl.
(The hinder parts of each, sev'n stars contain,
Called the lesser, and the greater-wain,)
The hare comes next, the bear-ward, and the crown,
Then hercules advances kneeling down:
Great serpentarius riding on his snake,
Doth next a formidable image make.
Under the tuneful harp of Orpheus
Are plac'd the Eagle, and Antinous.
The silver Swan her downy wings do spread
Above the dart, and sportive Dolphin's head:
Then Pegasus comes flying on amain,
Andromeda next follows in her chain:
(The Triangle at a small distance stands,
And at her feet you see in Perseus's hands,
The monstr'ous Gorgon's head; above are seen
Cepheus, with Cassiope his queen.
Auriga with his goat and kids appear
At last, which ends the northern hemisphere.

The twelve signs, or constellations of the Zodiack.

Between the north and south, all round the sky,
Just in the midst, twelve constellations lie
We call the signs; and first the Ram begins,
The Bull next follows, then the loving Twins.
The Sea-Crab, Lion, and the Virgin tender;
Then comes the Balance, Scorpion, and Bow-bender;
The bearded Goat, next follows in the train,
The Waterman comes next, then Fishes twain,
Do bring you round unto the Ram again.

The southern constellations.

Within the space o'th' southern hemisphere,
No more than fifteen images appear;
The monstrous Whale claims place before the rest,
Eridanus's streams flow near his breast.
The Hare is next, and then Orion bright,
Who shines most glorious in a winter's night.
Then comes the great dog Sirius, at whose tail
The famous Argo spreads her yielding sail;
Above her masts the little dog doth flame:
(This constellation hath no latin name.)
Next Hydra stretcheth out her tail afar;
The Crow and Pitcher, near it seated are:
The monstrous Centaure holds the Wolf by th' heel;
Then comes the Altar and Ixion's wheel.
The southern fish at last brings up the rear,
And thus you have the southern hemisphere.

About

About the ſouthern pole, far diſtant be
Twelve conſtellations, which we cannot ſee;
They're call'd the Craw, the arabian Phœnix, and
The Indian man, with three darts in his hand.
The bird of paradiſe, the little fly;
The fine tail'd Peacock, the Camelion fly;
The ſouth Triangle, and the ſouthern Snake;
The Toucon Gooſe with its long monſtrous Beak;
The fiſh Dorado, and the flying Fiſh;
Two magellanick clouds likewiſe there is.

1713

Of the reaſons why the antients brought the ſtars into theſe figures and repreſentations, according to Dr. Hook, and ſome others.

AND firſt the ſtars, if not preciſely, yet after a ſort, do repreſent ſuch a figure as they have depicted it by: thus the three ſtars over the head of the ram, that is in the ſhape of a triangle in the heavens, they have drawn upon the globes and maps of the fixed ſtars, the figure of a triangle: and the ſeven ſtars in the tale and back, both of the great and little bear, is called the greater and leſſer wain or waggon; becauſe it pretty well reſembles it, and ſo doth the crown and ſcorpion as ſome people imagine.

A ſecond reaſon was, to continue the memory of ſome notable men, who either in regard of ſome mighty and ſignal atchievement done, or in regard of their ſingular pains taken in advancing aſtronomy, had deſerved well of mankind; ſuch as Hercules, Perſeus, and others.

A third reaſon was (according to the ſuperſtition of the antients) that theſe images expreſs ſome properties of the ſtars that compoſe them; as thoſe of the ram, to be hot and dry; Andromeda chain'd, betokeneth impriſonment: the head of Meduſa cut off, ſignifieth the loſs of that part: Orion with his terrible and threatning geſture, importeth tempeſts and dreadful effects: the Serpent, the Dragon, and the Scorpion, ſignifie poiſon: the Bull inſinuateth a melancholy paſſion: the Bear inferreth cruelty, and the like.

And laſtly, beſides all this, the poets had this deſign touching the reaſon of the invention of theſe conſtellations, namely, to make men fall in love with aſtronomy; they ſaw that aſtronomy being of ſingular advantage to the life of

of man, was almoſt utterly neglected; hereupon, they began to ſet forth, that under fictitious and delightful ſtories, that thereby ſuch as could not be perſwaded by advantage, might by the pleaſure be induced to take a view of theſe matters, and thereby at length fall in love with them. Some of theſe poetical ſtories you may have hereafter.

1711

How to know the fixed Stars.

But cries the fair-inquiſitive, by what means or ways muſt I know theſe ſtars in the heavens?

I anſwer. There are divers ways or helps to know them; ſome of which I ſhall here put down.

1. The firſt way then to know the ſtars, is, by having the picture or repreſentation of the conſtellations by you, and knowing one or more ſtars in the heavens of the ſame conſtellation, by comparing the ſtars in the picture or figure, and thoſe in the heavens, and conſidering their ſituation, diſtances, and magnitudes in the one, you may eaſily find out thoſe in the other.

Thus for example, I would know the ſtars in the heavens of the conſtellation Taurus: I take the picture in my hand, and go out in ſome fair Night, and viewing the heavens, I find out the little cluſter of ſtars called the ſeven ſtars, (known almoſt by every body.) Then I look upon my picture, and obſerve, (holding the backſide of it towards that part of the heavens, and the picture of the conſtellation towards me.) I ſay I obſerve in the picture thus held, a large bright ſtar bigger than all the neighbouring ſtars, that is further from me, (or nearer to the earth) and more towards the eaſt or left hand, called Aldebaran: then I look up into the firmament, and there obſerving the ſame poſition, and bigneſs of the ſtars, I ſoon find out Aldebran; or the Bull's ſouth eye.

Having found out this ſtar, I look again on it, and in the figure of this conſtellation, I find five ſtars placed as in the margin, like a figure of five, or the Roman V. One of the 5 ſtars on the top of the roman V being Aldebaran, which I juſt now found out; and that theſe five ſtars make up a ſmall conſtellation, called the Hyades, I look then in the heavens, and conſidering Aldebaran as one of the tops of this V. I ſoon find out the Hyades, and that the other ſtar is the northern eye of Taurus. Now I would find out the two horns of the bull (or rather the two ſtars at the tips of his horns. To do which, I view my conſtellation or picture, and obſerve, if I imagine a line from the ſingle ſtar at the bottom of the V or Hyades, I laſt found out, to be extended ſtreight forwards on one ſide, and on the other ſide the V, each

line will go a little without side the north-horn, and the south-horn, both being towards the east or left hand of the V. Otherwise I may do thus; I find in it, that the Pleiades, (or 7 stars) and the Bull's eye (or Aldebaran) and the Bull's north-horn make a triangle; the sides from the Pleiades and from Aldebaran being pretty near equal, and something farther in distance, than it is from the Pleiades to Aldebaran; I look then in the heavens, and soon find the north star out. and by that the south horn is easily found, being nearer towards the earth and about half the distance, as it is between the Pleiades and Aldebaran.

Or I might consider the Pleiades and Aldebaran, and the north and south-horns as a Trapeza, or 4 sided figure, and that the two nearest stars, (or shortest side) is towards the left-hand; and by this means find them out in the heavens: And the like may be done for the finding out of any other stars, in this constellation, or of any other, from the knowledge only of but one or more stars therein.

If you suppose a line drawn from Aldebaran, to the Pleiades, and continued near double their distance farther, you will find out the triangle over the Ram (or Aries) and by that you may find out the rest of the Ram as before directed.

Or if you imagine lines drawn from the Hyades, by the north and south horns of the Bull, and continue them about double that distance, they will include two bright stars, called Castor and Pollux, in the sign Gemini; from which, and the printed constellation above, the others may be easily found out; and the like for all the rest.

2. A second way is by the passing of some of the planets, but especially the moon through the signs, or by some eminent stars, to find them out.

3. A third way to know the fixed stars, (and also the planets by) is when they come to south, and if withal you have their height given, and then by a quadrant, find their heighth in the heavens, you may with great certainty and ease find them out.

4. A fourth way, is by their rising and setting.

5. A fifth way to know the fixed stars, is by some instrument, or by the globes.

Of the Eclipses this present year, 1704.

This year there will be 4 eclipses, whereof two will be of the sun, and two of the moon, but none can be seen in England, but a small one of the moon, which happens upon the thirtieth day of November: Its beginning will be about a quarter of an hour past six in the morning; the greatest darkness will be at half an hour past seven; and its end at half an hour past eight a clock; and she will set eclipsed *.

Of

* Of these eclipses I find no observations.

Of the Eclipses this present year, 1705.

There will be but two eclipses this year, and both of the sun, and both of them invisible to us in England. The first of them on the 11 of May, about eight a clock in the evening. The other upon gunpowder treason day, at two a clock in the afternoon †.

The times of the Eclipses this year, 1706.

There will be four eclipses this year. The first of the moon, April 16. it begins at 5 minutes after midnight, greatest obscuration at 18 min. after one the next morning, and ends 32 min. after 2. digits eclipsed 5. The second is a great eclipse of the sun on May day‡, of which see in the beginning. The third

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† Of these eclipse also I find no observations on record.

‡ As accurate observations of eclipses may be of use in determining the degree of accuracy that obtains in astronomical tables; either by comparing the observations with the calculations which we find made by any one (supposing him to have calculated truly), or with accurate calculations which any person may make for that purpose; I shall subjoin, by way of notes, to every years predictions, such observations of eclipses as I find recorded in the *Philosophical Transactions, Leipsic Acts,* &c. And shall here begin with that on May $\frac{1}{12}$ (viz. 1st day old style, or 12th of the new) this year, it being the first I find upon record.

In the *philosophical transactions* are these following observations: which however are not the most perfect, on account of the frequent clouds which often covered the sun.

1. At *Greenwich*, by Mr *Flamstead.*

Correct time by the pend. Clock. h.	m.	s.	
8	21	30	A very small part of the sun's diameter was eclipsed.
8	28	00	The chord of the arch of the sun's periphery eclipsed was 14′ 40″.
9	21	46	The parts of the diameter remaining clear 5′ 40″.
9	26	20	The same — — — — 4 30.
10	31	50	The sun appeared through the breaks of the clouds and shewed the eclipse not ended. Clouds again till
10	33	50	When the sun shone out again, we saw his limb intire, and the eclipse certainly over.

2 At

third is of the moon, Oct. 10. It begins nineteen minutes after 6 in

2. At *Canterbury*, by Mr *S. Gray.*

Correct time by the pend. clock. h. m.	
8 53	digits $5\frac{1}{2}$ darkened.
9 08	—— 7
9 31	—— 10 or more
9 36	The sun shining for a short time, the eclipse seem'd to decrease.
9 55	—— $7\frac{1}{2}$ a little clearer.
9 57	—— $6\frac{3}{4}$
10 02	—— 6
10 04	—— $5\frac{3}{4}$
10 14	—— 4
10 16	—— $3\frac{3}{4}$
10 20	—— $2\frac{1}{2}$
10 30	—— 1
10 31	—— $0\frac{3}{4}$
10 $36\frac{1}{2}$	The end accurately with a tube of 16 feet.

3. At *Horton* near *Bradford* in *Yorkshire*, by Mr *A. Sharp.*

Correct time. h. m. s.	
8 35 00	digits dark 3 } by ocular estimation.
9 01 00	—— —— 7 }
9 04 54	—— —— $8\frac{3}{10}$ eclipsed on the scene.
9 06 33	—— —— $8\frac{1}{2}$
9 07 53	—— —— $8\frac{6}{10}$
9 12 50	—— —— 9
9 16 08	—— —— $9\frac{4}{10}$
9 18 48	—— —— $9\frac{1}{2}$ exactly, the sun shining out clear.
9 20 45	—— —— $9\frac{1}{2}$ the sun still clear. Greatest obscurity.
9 21 48	—— —— $9\frac{1}{2}$ still clear.
9 28 46	—— —— 9
9 44 45	—— —— 7
9 54 42	—— —— $5\frac{1}{4}$
10 06 10	—— —— $3\frac{1}{2}$
10 19 55	—— —— 1 precisely.
10 24 00	The sun seen through clouds; the eclipse not ended.
10 30 00	The sun seen again perfectly round and intire.

4. At *Bern* in *Switzerland*, by Capt. *Stannyan.*

Captain *Stannyan*, from *Bern* in *Switzerland*, writes, that the sun was totally darkened there for $4\frac{1}{2}$ minutes of time; that a fixed star and a planet appeared very bright; and that *his getting out of the eclipse was preceded by a blood-red streak of light, from its left limb, which continued not longer than 6 or 7 seconds of time*; then part of the sun's disk

6 in the evening, greateſt obſcuration 38 min. after 7, ends about

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diſk appeared, all on a ſudden, bright as venus was ever ſeen in the night ; nay, brighter ; and in that very inſtant gave a light and ſhadow to things, as ſtrong as moon light uſes to do.

Upon this the writer of the tranſactions obſerves that

The Captain is the firſt man I ever heard of, that took notice of a red ſtreak of light preceding the emerſion of the ſun's body from a total eclipſe : and I take notice of it, becauſe it infers that *the moon has an atmoſphere* ; and its ſhort continuance of only 6 or 7 ſeconds of time, tells us, that *its height is not more than the 5 or 6 hundredth part of her diameter.*

5. At *Geneva*, by *Mr J. C. Facis* Duillier.

This gentleman could ſee neither the beginning nor end of the eclipſe ; and all that can be collected from his account, is that the duration of the total darkneſs or total immerſion was preciſely 3 minutes ; that during the time of the total darkneſs, a whiteneſs ſeemed to break out from behind the moon, and to encompaſs it on all ſides equally, its breadth being leſs than one-twelfth of the moon's diameter, and was but ill determined in its outward ſide ; that a little after the ſun began to appear again, the whiteneſs entirely vaniſhed ; and that ſeveral ſtars and planets were ſeen.

The ſame gentleman ſaith that, according to *Mr* Profeſſor *Gautier*'s obſervations, from the emerſion of the ſun to the end of the eclipſe, there was 1 h. 9 m. 30 s.

He alſo ſaith that the ſame gentleman communicated to him the following obſervations made

6. At *Marſeilles* by *Mr Chazelles* and *Father Laval.*

	h.	m.	s.
At *Marſeilles* the eclipſe began at — — —	8	28	40
It reached the ſun's center at — — —	9	6	11
It was total at — — — — —	9	34	15
The ſun began to appear again at — —	9	37	9
The eclipſe came again to the center at — —	10	12	23
It entirely ended at — — — —	10	47	50

Three ſtars were diſtinctly ſeen ; and during 3 minutes it was not poſſible to read. And there remained one bright digit, all about the globe of the moon.

The manor houſe of *Duillier* is in the latitude of 46° 24′ ; in longitude it is 4° 13′ 45″ to the eaſtward of the royal obſervatory at *Paris.* And *St Peter's Church* at *Geneva* is, in latitude, 0° 12′ to the ſouthward, and, in longitude, 0° 5′ 2″ to the weſtward of *Duillier.*

7. At *Zurich*, by *Dr J. J. Scheuchzer.*

We have had here, may 12, both a total and annular eclipſe of the ſun ; total, becauſe the whole ſun was covered by the moon ;

about 4 min. before 9, digits eclipſed 7 and three fourths. The fourth

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annular, though not properly ſo called, but by refraction, for a ruddy brightneſs appeared about the moon, ariſing from the rays refracted by the moon's atmoſphere.

	h.	m.
The beginning of the eclipſe was in the morning	8	54
The middle — — — — —	9	58
The end — — — — —	11	12

The mora of the mean and full obſcuration 4m.

Both the fixed ſtars and planets might be ſeen. The birds betook themſelves to their neſts. The bats came out of their holes, and the fiſhes ſwam upon the water. We ourſelves perceived a ſenſible degree of cold, and the dew fell down upon the plants.

The following obſervations, of the ſame eclipſe, are extracted from the *Leipſick Acts of the Learned.*

8. At *Leipſick.*	h.	m.	s.
The beginning of the eclipſe at about —	9	15	0
The greateſt darkneſs — —	10	25	20
The end — — — —	11	35	45
The duration of the eclipſe about —	2	21	0

There was ſcarcely one-third of a digit of the ſun's diſc uneclipſed; and ſeveral fixed ſtars, with the planets mercury, venus, jupiter, and ſaturn were viſible. A ſhining ring was alſo obſerved ſurrounding the moon, parallel to its limb; it was denſer in that part towards the moon, and rarer in the other part which was fartheſt from it; but it was, nevertheleſs, bounded by a very accurate periphery, and plainly to be diſtinguiſhed from the uneclipſed part of the ſun, which was above it towards the zenith. It was leſs than the uneclipſed portion of the ſun's diſc, and its brightneſs was like that of ſilver. The edge of the moon was pale like clouds, whilſt the inner part of the diſc was quite black.

9. At *Jena (viz. Eyſenach or Iſenack,* in the Marquiſate of *Thuringia* in *Upper Saxony)* by profeſſor *Hambergerus.*

	h.	m.	s.
The beginning — — — —	9	11	40
The middle — — —	10	21	59
The end — — — —	11	32	18
The whole duration — —	2	20	38

The digits eclipſed $11\frac{5}{6}$.

When the darkneſs was greateſt, he ſaw venus, jupiter, and capella. And ſo great was the darkneſs, that he was obliged to light a candle, in order to diſtinguiſh the minute and ſecond pointers of his pendulum clock, which was placed in the window.

10. At

fourth is of the ſun, oct. 25*. at 3 in the afternoon, inviſible.

The

10. At *Berlin*.

	h. m.
The beginning — —	9 24′
The end — — —	11 45

The digits eclipſed were $11\frac{7}{8}$

11. At *Uratiſlavia* (viz. *Breſlaw* in *Sileſia*) by R. P. *Chriſtopher Heinrich*, profeſſor of divinity and mathematics.

	h. m. s.
The beginning of the eclipſe — — —	9 39 40
The beginning of total darkneſs — —	10 49 0
The middle — — — —	10 49 30
The end of total darkneſs — —	10 50 0

	h. m. s.
The end of the eclipſe — — —	12 2 20
The duration of total darkneſs — —	0 1 0
The duration the eclipſe — —	2 22 40

The diameter of the moon exceeded that of the ſun by only 15″ of the ſun's diameter.

At the time of the total darkneſs, ſeveral ſtars were very eaſily ſeen, eſpecially two near the ſun. And a circle of a faintiſh light ſurrounded the moon like a halo.

At 10 h. 6 m. 30 s. when 5 digits of the ſun were darkened, a parabolic ſpeculum, of 3 feet diameter, juſt ſet fire to dry wood; which it would not do at 10 h. 18 m. 20 s. when 7 digits were eclipſed.

At 10 h. 35 m. 30 s. when 10 digits were obſcured, it juſt ſcorched a piece of rag.

At 10 h. 42 m. 0 s. when 11 digits were darkened, it would not fire any inflammable ſubſtance.

A burning lenſe, $9\frac{1}{2}$ inches diameter, when 9 digits were eclipſed, at 10 h. 30 m. juſt ſcorched the rag; but when 10 digits were darkened, it would no longer light any inflammable matter.

The ſky, during the whole time, was remarkably ſerene.

* In the philoſophical tranſactions it is recorded that

This eclipſe was obſerved at the town of *S. Ignatius* in Paragua, where the altitude of the ſouth pole is 26° 52′, and its merid. diſt. from the R. obſerv. at *Paris* 3 h. 57 m. 50 s, by *F. Bonaventura Suarez*, miſſionary to that place.

		h. m.
Beginning of the eclipſe, Nov. 5 N. S. —		8 52 *A. M.*
Digits obſcured	2 — — — at	9 15
	$3\frac{1}{2}$ — — — —	9 40
	4 — — —	10 0
	1 — —	11 5
The end at — — — —		11 15

The greateſt quantity 4 dig. at 9h. 50m. The times by a pendulum, rectified to true time, by the altitude of the fixt ſtars.

† This

1707

The Eclipſes this year.

There will be ſix eclipſes this year. 1. A ſmall eclipſe of the ſun at his ſetting mar. 22 inviſible. 2. A total eclipſe of the moon †april 6. of which ſee in the beginning. 3. An inviſible ſmall eclipſe of the ſun on april 21, at 2 in the morning. 4. A very ſmall eclipſe of the ſun ſept. 14 about midnight. 5. A great eclipſe of the moon at noon day ſept. 30. inviſible. 6. An eclipſe of the ſun october 14. about 3 a clock in the afternoon, but inviſible to us. A famous ☌ ♃ ♂ in ♍ july 9 at 10 at night.

Two Arithmetical Enigmas.

1. In how long time would a million of millions of money be in telling, ſuppoſing one hundred pounds to be counted every month, (without any intermiſſion day or night, ſunday or work-day) till all be told?

2. If to my age there added be
One half, one third, and three times three;
Six ſcore and ten the ſum you'ld ſee,
Pray find out what my age may be?

The

† This eclipſe was obſerved as follows:

1. At *Boſton* in *New England*, by Mr *T. Brattle.*

April 5. N. S. — Time corrected by altitude.

		h.	m.	s.	
A very notable penumbra	—	6	52	0	P. M.
The moon quite immerſed	—	8	1	15	
The moon plainly began to emerge	—	9	46	30	
The moon is fully illuminated	—	10	54	0	

2. At *Zurich*, by the two Doctors, *Scheuchzer's.*

		h.	m.	s.	
The penumbra on the ſide of *maræotis*	—	12	9	18	night.
The true ſhadow within the diſc	—	12	18	40	
The whole body of the moon in the ſhadow		1	23	20	morn.
The true beginning of the emerſion	—	3	9	40	
The penumbra	— — —	4	13	40	
All the moon entire	— — —	4	14	20	
The duration of total obſcuration	—	1	46	30	
The whole duration of the eclipſe	—	3	55	50	
From the beginning to the total immerſion		1	4	40	
From the emerſion of the total eclipſe to the end		1	4	40	

3. At

1708

The Eclipses of this Year.

In this year will be four eclipses, namely, two of the sun, and two of the moon. The first is of the sun, the 11th of march, near 7 in the morning, but invisible to us. The 2d* is of the moon, march 25, about 6 in the morning: she will be above half eclipsed, but not much visible, because the sun will rise before the middle of the eclipse. The 3d † is of the sun, september 3, about 9 of the clock in the morning; it will be a visible eclipse, and about a third part of his diameter

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3. At *S. Ignatius*, by the missionary *F. Bon. Suarez.*

April 16, N. S.	h. m.
Beginning — — — —	7 55 *P. M.*
Total obscuration — — — —	8 58
Beginning of emersion — — —	10 45

The end was not observed because of clouds.

* This eclipse was observed at *Paragua*, by *F. Bonaventura Suarez*, thus: 1708 april 4 *P. M.* N. S.

Immersion of the moon	h. m. s.	*Emersion of the moon.*	h. m. s.
Into a sensible penumbra	12 18 0	Aristarchus —	14 13 15
Into the shadow —	12 30 29	Plato — —	14 15 0
Aristarchus obscured	12 13 11	Out of the shadow	15 3 0
Plato obscured —	12 46 0	Out of the penumbra	15 12 0

† This eclipse was observed at *Upminster*, by Mr *Derham*, thus:

The correct app. time	
	The beginning could not be seen for clouds.
h. m. s.	
6 44 15	The sun peeped out of the clouds, and about one-tenth of a digit was eclipsed. Then clouds most of the time. But at
8 31 15	A little obscuration appeared through the telescope.
8 32 45	A very little obscuration through the telescope.
8 35 45	We could discern no remains of the eclipse through the telescope.

From these observations I imagine the end of this solar eclipse was much about 8h. 33m. in the morning.

ter will be hid on the north part. The 4th * will be of the moon, ſeptember 18, near nine at night; it will be about 5 digits and a quarter eclipſed, and may be ſeen if the night proves clear.

A Letter to the Author.

SIR,

READING in a book of geography the other day, I found to my great ſurpriſe, the following paradoxes.

There is a certain place in the globe, of a conſiderable ſouthern latitude, that hath both the greateſt and leaſt degree of longitude.

There are three remarkable places on the globe, that differ both in longitude and latitude, and yet all lie under one and the ſame meridian.

There is a certain iſland in the baltic ſea, to whoſe inhabitants the body of the ſun is clearly viſible in the morning before he riſes, and likewiſe in the evening after he is ſet.

There is a certain village in the kingdom of Naples, ſituate in a very low valley, and yet the ſun is nearer the inhabitants thereof every noon by 3000 miles and upwards, than when he either riſeth or ſetteth to thoſe of the ſaid village.

There

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* At *Upminſter* Mr *Derham*, obſerved it, and records it thus:

As I was coming from *London*, ſept. 18, in the evening, I obſerved, for half an hour or more, a thin ſhade to poſſeſs that part of the diſc where the eclipſe began, which remained a good while after the eclipſe was over. After I got home, I got all things in readineſs before the eclipſe began. The principal obſervations were as follow:

The correct app. time. h. m. s.	
7 56 30	A thin penumbra.
7 57 40	A darker penumbra.
7 59 0	Yet darker, which may paſs for the beginning of the eclipſe.
8 0 0	The eclipſe no doubt begun.
9 1 0	The lucid parts of the moon, not long before the middle of the eclipſe, were 925 parts of my micrometer.
9 16 40	Diameter of the moon 1634 parts of the micrometer.
10 23 11	The end of the eclipſe draws nigh.
10 25 0	A little obſcuration
10 26 0	Leſs.
10 28 15	A very little, excepting the duſkiſhneſs before mentioned.

There is a certain remarkable place of the earth, of a conſiderable ſouthern latitude, from whoſe meridian the ſun removeth not for ſeveral days at a certain time of the year.

There are ten places in the earth diſtant from one another 300 miles and upwards, and yet none of them have either longitude or latitude.

Theſe things, Sir, to me ſeem impoſſibilities; I ſhould be glad to know your opinion of them in your next Diary.

I am, Sir, yours, &c.

The Anſwer.

SIR.

ALL theſe particulars are very true, as I ſhall plainly make appear in my next. *I am, Sir, yours,*

Coventry, Auguſt the 9th, 1707. J. TIPPER.

The Arithmetical Queſtions.

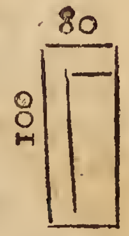
In my laſt, I ſet down two arithmetical queſtions. The age of the perſon in the ſecond queſtion, is 66 years.* But the firſt Queſtion was falſely printed, a month being put down for a minute; I have therefore here repeated it again, with four more which I have received from ſeveral parts of the kingdom.

Arithmetical Queſtion 1.

In how long time would a million of millions of money be in counting, ſuppoſing one hundred pounds to be counted every minute without intermiſſion, and the year to conſiſt of 365 days, 5 hours, 45 minutes?

Queſtion 2.

A gentleman a garden had,
Five-ſcore foot long, and four-ſcore broad,
A walk of equal breadth, half round
He made, that took up half the ground;
(The figure in the margin ſee,)
How wide's the walk pray tell to me?



Queſtion

*The meaning of the problem is, that the number 9 added to once his age together with one-half and one-third of his age, the ſum ſhall be 130; or, ſince the ſum of the parts 1, and $\frac{1}{2}$, and $\frac{1}{3}$ is $\frac{11}{6}$, that $\frac{11}{6}$ of his age is (130—9=) 121; conſequently 11 : 6 : : 121 : 66 = his age.

Question 3.

If thirteen tun of claret wine, coſt nineteen engliſh pounds;
How many pints of the ſame wine, are worth a thouſand crowns?

Question 4.

If thirteen marks and fourteen groats, buy fifteen loads of hay;
How many pounds, with ſixteen crowns, for ninety loads will pay?

Question 5.

When firſt the marriage knot was ty'd
Betwixt my wife and me,
Mine age did hers as far exceed
As three times three, doth three:
But after ten and half ten years
We man and wife had been;
Her age came up as near to mine
As eight is to ſixteen.
Now tell me, if you can, I pray,
What was our age o' th' marriage day?

1709.

Anſwers to the geographical paradoxes propounded in the laſt year's diary.

Solution of Paradox 1.

ALL places that lie under the firſt meridian, have both the greateſt and leaſt degree of longitude, and from any of them you may begin or end your reckoning, let the latitude be what it will; and the words of a conſiderable ſouthern latitude, are but a blind to make the queſtion more obſcure: for as we ſay of the moment of time when it is noon (according to aſtronomers) that it is the end of the former day, or the beginning of the enſuing; ſo we may ſay of all places under the firſt meridian, that they be the greateſt number of degrees of longitude that can be, or otherwiſe the beginning and leaſt number thereof.

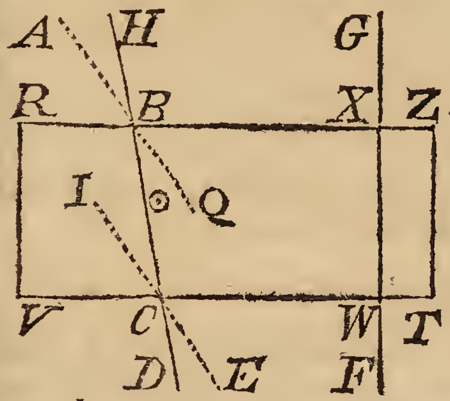
Solution of Paradox 2.

By the globe is here meant the artificial globe, and the meridian the brazen circle belonging thereto; then admit the firſt

firſt place was in 10 deg. of longitude, and under the tropick of cancer; the ſecond place under the north pole; and the third lie under 8 deg. (or any other number from the equator) but in the oppoſite meridian: then it will follow, that the firſt place hath 10 deg. long. and 23 deg. and a half lat. The ſecond place hath 0 deg. lon. and 90 deg. lat. and the third place hath 190 deg. long. and 8 deg. lat. and all lie under the ſame brazen meridian, which anſwers all the conditions of the paradox.

Solution of Paradox 3.

In order to ſolve this paradox, it is neceſſary to know the nature of refraction, and what is the cauſe thereof, which I ſhall endeavour to explain in a few words.



Suppoſe a body of glaſs *R Z T V* in form of a parallelopipedon or of an ordinary brick (the length and breadth is *R Z* and *Z T*, but the thickneſs you muſt imagine.) Suppoſe from an eye at *G* in the open air (being a light expanded body) a ray of light fall perpendicular upon the tranſparent (but a denſe cloſe compacted body compared to the air) it will paſs to the other ſide the glaſs *W*, and ſo continue to *F*, without any refraction at all.

But if from the eye placed at *A*, the ray paſſeth obliquely to *B*, it will not proceed in a direct line to *Q*, but bend or be refracted (towards you) to *C*. And when it comes to *C*, the ray will not continue in a ſtreight line from *B C* to *D*. But (coming out of a denſe body, to a more rare, light, and expanded one,) it refracts towards *E*; and if the top and bottom of the glaſs are parallel, the line *E C I* will be parallel to *Q B A*

Suppoſe now *A Q* to be the horizon of ſome iſland in the baltick ſea, (or elſewhere) when therefore the ſun comes to *Q*, he is juſt truly riſen; yet by reaſon of the refraction of the vapours and clouds near the horizon, he will appear to an eye place at *A*, as if he was really riſen as ſoon as he comes to ☉; and the ſame it will be after his ſetting in the evening, which truly anſwers the demand.

This alſo ſolves the queſtion, why a piece of money in a baſon filled with water, ſhall appear, which when it was empty, could not be ſeen.

Solution of Paradox 4.

When the ſun riſeth in the horizon of any place, (be it Naples or any where elſe) he is the ſpace of the ſemidiameter

ter of the earth more diſtant from that place, than when he is in its meridian at noon. Now there being but an inconſiderable proportion between the depth of the loweſt valley in the world, and the ſemidiameter of the earth, (which is above 3600 miles) it follows, that the ſun muſt be 3000 miles and upwards nearer at noon, than at his riſing, there being no valley the tenth part of 600 miles deep.

Solution of Paradox 5.

There are ſome that do ſay the place muſt be under the ſouth pole, but I take the ſolution to conſiſt rather in the equivocalneſs of the words from whoſe meridian the ſun removeth not; for by this expreſſion is not meant, that the ſun ſtands ſtill in the meridian, but that he conſtantly ſhines upon, or enlightens the meridian of the place, as long as he is above the horizon, which is in ſuch places beyond the artick circle on which the ſun ſhines ſeveral days; as ſuppoſe in 68 deg. ſouth lat. (for that latitude the queſtion requires) for there the ſun departs not from the meridian, *i. e.* ſhines upon it conſtantly, for 30 days together, *&c.*

Solution of Paradox 6.

The places are ſaid to be in the earth and not upon it, (for longitude and latitude are reckoned upon the ſurface of the globe only.) So the axis of the earth (or any other imaginary line through it) being about 7200 italian miles, will not only anſwer the paradox; but if inſtead of twelve places, he had ſaid twenty-four, it would have kept within the poſſibility of the demand.

Moſt of theſe paradoxes were anſwered by Mr Robert Winſton, of Plimton, near Plymouth; and ſome of them by Mr Moyle, of Gwennap, in Cornwal.

Of Arithmetical Queſtions.

ARithmetical queſtions are as entertaining and delightful as any other ſubject whatſoever, they are no other than enigmas, to be ſolved by numbers; and indeed the ſubtilty of numbers are ſo ſtrange, that to them who are unacquainted with them, would ſeem impoſſible, and many queſtions, that in appearance ſeem a trifle, in conſequence exceeed all human belief. This puts into my mind a ſtory I have read in Dr Willis's book, called opus arithmeticum. Namely, "that "one Seſſa an Indian having firſt found out the game at cheſſe, and ſhew'd it to his prince Shehram; the king, who "was highly pleaſed with it, bid him aſk what he would for "the reward of his invention; whereupon he aſk'd, that for "the firſt little ſquare of the cheſs-board (or boards to play

"at

" at drafts on) he might have one grain of wheat given him; " for the ſecond, two; and ſo on doubling continually according to the number of ſquares in the cheſſe board, which was " 64. And when the king, who intended to give a noble " reward, was much diſpleaſed, that he had aſk'd ſo trifling " a one; Seſſa declar'd, that he would be contented with this " ſmall one. So the reward he had fix'd upon, was order'd " to be given him: but the king was quickly aſtoniſh'd, when " he found that this would riſe to ſo vaſt a quantity, that the " whole earth itſelf could not furniſh out ſo much wheat.

This ſtory the doctor believes gave riſe to that new queſtion concerning a horſe, which ſhould be ſold according to the number of nails in his ſhoes, by continually doubling of them; and this likewiſe gave occaſion to the firſt arithmetical queſtion following, of a merchant ſelling ſome extraordinary diamonds being 64 in number, which I compoſed on purpoſe to anſwer the queſtion propounded in the ſtory above recited, which you ſhall have anon afer I have ſet down

The anſwers to the laſt year's Arithmetical Queſtions.

Anſw. to the firſt is, 19013 years, 144 days, 3 hours, 38 minutes, ſay ſome; others agree in years and days, but ſay it is 5 hours 55 minutes.*

Anſwer to the ſecond is, 26 feet near, or more truly 25·968757762 57.†

The

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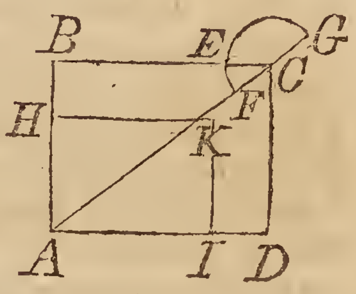
* The ſolution of this queſtion is evidently thus: As 100 *l.*: 1 minute :: 1000000000000 *l.* : 10000000000 minutes = 19013 years 144 days 5 hours 55 minutes, the true time required.



† This problem, I think, may be moſt elegantly conſtructed thus: $ABCD$ being the given rectangle, make $BE = BA$, and CF and CG (on the diagonal) each $= CE$; then making $AH = \frac{1}{2} AF$, and $AI = \frac{1}{2} AG$; and compleating the rectangle $AHKI$, the thing is done. For, the area $= HA \times AI = \frac{1}{2} FA \times \frac{1}{2} AG = \frac{AC - \overline{CB - BA}}{2} \times \frac{AC + \overline{CB - BA}}{2} = \frac{AC^2 - \overline{CB - BA}^2}{4} = \frac{CB \times BA}{2} =$ half the whole area.

And $IA - AH = \frac{GA - AF}{2} = CF = CB - BA$, as it ought.

The

The number of pints in the third queſtion are $344842\frac{2}{19}$*

Anſ. to the fourth qu. is, 49 l. 8 s. beſides the 16 crowns.‡

The anſwer to the fifth and laſt queſtion I received in verſe, from Mr Proſſer, as follows,

When firſt the ſolemn knot was ty'd,
Your wife was juſt fifteen;
You by proportion forty-five,
Which is as three to nine.
But when your hoary head arriv'd
To ten and half ten more,
Your youthful bride ſaw thirty years,
And you could tell threeſcore.
Thus have I told without delay,
What was your age o' th' marriage day.†

Mr

The numerical calculation will come directly from the conſtruction thus: The required breadth HB is $= BA - AH = BA - \frac{1}{2}AF = BA - \frac{AC - \overline{CB - BA}}{2} = \frac{CB + BA - AC}{2} = \frac{100 + 80 - \sqrt{16400}}{2} = 90 - \sqrt{4100} = 25{\cdot}968757625671 5.$

The Algebraic Solution.

Put $a = CB$, $b = BA$, $d = a - b$, and $z = AH$. Then $HA \times AI = z \times \overline{z + d} = \frac{1}{2}ab$; hence $z = \frac{\sqrt{2ab + dd} - d}{2} = \frac{\sqrt{aa + bb} - a + b}{2}$, and $BH = b - z = \frac{a + b - \sqrt{aa + bb}}{2} = \frac{CB + BA - AC}{2} =$ half the ſemiperimeter minus half the diagonal, the ſame as above.

* *Queſt.* 3.—As 19 *l.* : 26208 pints = 13 tuns : : 250 *l.* = 1000 crowns : $344842\frac{2}{19}$ pints.

‡ *Queſt.* 4.—As 15 loads : 90 loads : : 1 : 6 : : 178 *s.* = 13 marks + 14 groats : 1068 *s.* = the value of 90 loads. From which deducting 80 *s.* = 16 crowns, leaves 988 *s.* = 49 *l.* 8 *s.* or $49\frac{2}{5}$ *l.* for the number required.

† *Queſt.* 5.—Put z and $3z$ for the two ages, and $a = 15$; then $2 : 1 :: 3z + a : z + a$, or $3z + a = 2z + 2a$; hence $z = a = 15$, and $3z = 45$.

But perhaps the more maſterly way of ſolving this problem is thus: ſince $2 : 1 :: 3z + a : z + a$, ſubtract each conſequent from its antecedent, and we have $1 : 1 :: 2z : z + a$;
but $1 : 1 :: z : z$, hence,
by ſubtracting, $1 : 1 :: z : a$; or $z = a =$ the number added univerſally.

Mr John White, of Butterly, in Devonſhire, ſends me word he overheard ſome of his plain country plow-men diſcourſing about the firſt queſtion (of counting the money) in their country dialect, the ſubſtance whereof was as follows.

Says Tom 'twol be vorty long days,
I and vorty to that ſays Will;
'Twant be told in a year quoth Jack,
No nor in zov'n years cries Jill;
You talk all like vools ſaith Roger,
A Merchant with's two vore veet,
Will ſcrape it away in a month,
And thereto I'll wage you a ſheep;
Go blockhead, quoth Beſs, that was brewing,
The boy that weighed my hops,
Woll tell it all in a week,
Zo will any mon in the ſhops.

All theſe arithmetical queſtions were anſwered by Mr John Jolly, of Buglawton, in Cheſhire; Mr John Boſwell, of Harlſton, in Northamptonſhire; Mr Robert Winſton, of Plymton; Mr Micock, and W. P.

The three laſt by the gentleman of Modbury; and by him who ſtiles himſelf Antenor; Mr Moyl; Mr Yates, of Henly, in Arden, &c.

The difference of the anſwer in the firſt queſtion ariſeth from this, viz. That after the firſt diviſion is ended, to find the number of years, one takes the remainder to be all minutes, and turns them into days, hours, and minutes directly. But the other makes the parts of the year, in the ſame proportion as the whole years, by multiplying the remainder, by the next inferior denomination, and dividing the product by the common diviſor, &c.

The eclipſes of this year.

This year there be two eclipſes, and thoſe both of the ſun. The firſt is a ſmall viſible eclipſe, on the 28th of february, about noon, or rather a little after; the digits eclipſed are 3. The ſecond is on the twenty-fourth of auguſt, it will be a great eclipſe, but to us inviſible, it happening to be about one a clock in the morning. *

Theſe eclipſes happening the one before, and the other after the ſuns apogæon, there can be no full-moon eclipſe this year *New*

* From *F. Bonaventura Suarez's* obſervation of this eclipſe at *Paragua*, it appears that the eclipſe ended at 7 h. 37 m. 15 s. and that the greateſt obſcuration was $9\frac{1}{4}$ digits. He ſaith, the ſun roſe at 5 h. 53 m, and that the eclipſe had begun before then.

New Queſtions.

I *Queſtion* 6.

A rich indian merchant, had diamonds good ſtore
Of extraordinary value, in the whole ſixty four;
Who brought them to ſell to a perſian king,
Who aſk'd him the value each diamond would bring:
Quoth he for the firſt ſtone, I will have but one grain
Of your beſt indian wheat, for the next, I'll have twain;
For the third, I'll have four grains, and for the fourth, eight;
So doubling the laſt ſum, till all are complete.
Done! done! (ſaith the king,) with a great deal of pleaſure,
Who thought for a trifle he had purchas'd a treaſure;
And calls for, (jocoſely) a bag of wheat out,
Saying count, for there's more than enough without doubt.
But when for ſome hours, the grains they did count,
They found to ſuch vaſtneſs the whole would amount,
That all the whole kingdom, and ſeveral more,
Could not yield ſo much corn as would pay of the ſcore.
The king being pleas'd with the merchants great wit,
Gave him good ſtore of gold for his bargain to quit.
Propoſe now each buſhel of wheat worth a crown,
And juſt half a hundred did weigh:
And ſuppoſe a corn-pint held ten thouſand wheat grains;
Theſe two queſtions anſwer I pray.
(1.) What number of horſe loads (* thouſand pounds each,)
Muſt be us'd to ſupport this great treaſure?
(2.) And how many ſhips, each a hundred tun freight,
Would ſuffice to tranſport the wheat hither?

II *Queſtion* 7.

Quoth Jack to Tom, your Age and mine
Are both the ſame; and Valentine
My eldeſt ſon's juſt half my years,
(As by the regiſter appears.)
If theſe three ſums you multiply
One in another continually,
And to their product (drawn at length)
Add five times ſixty-eight, one tenth; (i. e. $340\frac{5}{10}$)
The whole to thirtythouſand will amount,
What is each age? come try your ſkill and count?

III *Queſtion* 8

A vint'ner would mix three ſorts of wine
Of various rates; the firſt was very fine,
The price eight groats the quart; the other two
Were

* Sterling ſilver money.

Were five and four groats each, now he would brew
Fifty ſix quarts together, in ſuch ſort
To ſell't for two and twenty pence a quart:
How many anſwers in whole numbers may
Be found to ſolve the queſtion; tell me pray?

IV *Queſtion* 9.

Sev'n men did buy a grinding-ſtone,
  Of five foot in diameter:
And they agree among themſelves,
  That each ſhall grind an equal ſhare,
And that one man ſhould firſt begin
  To grind his ſeventh part off the ſtone;
And then another ſhould grind his,
  And ſo continue one by one.
How much each man for's part muſt grind?
Is what you are requir'd to find?

V *Queſtion* 10.

Thoſe pendulum clocks, by experience is found,
Whoſe ſwing in a minute, make ſixty rebounds,
(As by tryal you'll find if you meaſure their lengths,)
Will contain juſt thirty nine inches, two tenths.
If ſo; then how long muſt that pendulum be,
That ſhall make the ſame number of ſwings to agree
With the number of inches its length doth contain,
(In the ſpace of a minute;) I'd know very fain?

1710.

Solutions to the laſt year's queſtions.

Solution of queſtion 6, *by a Lady.*

Suppoſe, (ſaith ſhe) navigation to have begun with Adam, and 67279 ſhips of 100 tun each to have been built every year ſince the creation of the world, (which ſhe ſuppoſes to be about 5655 years;) and ſo to build the ſame number continually to the end of the world, and the world to laſt 5000 years longer, and all thoſe ſhips to be in being at once; all of them together (according to the tenour of the queſtion) would not be ſufficient to tranſport the wheat, ſo prodigious is the quantity. She adds,

For th' horſes muſt be (as ſure as your alive)
Of millions, ſev'n thouſand, two hundred, and five;
Of thouſands, ſev'n hundred, fifty, and nine;
Of units four hundred, and three; (very fine!) To

To carry the caſh, ſir; and then 'tis as plain
Juſt ſo many ſhips will bring o'er the grain.
I ſhall not ſtand much on the fractional part;
E'en take it i' the bargain with all my heart.

i. e. 7205759403 horſe loades, (beſides 792*l.* 15*s.* 10*d.* odd money,) and the ſame number of ſhip-loads.*

Solution of queſtion 7.

If thirty nine you multiply by thirty nine, 'tis plain,
That fifteen hundred twenty one you by that work will gain;
This drawn into nineteen, five tenths, the age of his firſt ſon,
To th' product add the *ſum propos'd, and ſo the work is done. *$340\frac{5}{10}$

i. e. Jack and Tom's age is 39 years each and Valentine's 19 years and an half.†

Solution of queſtion 8.

To mix the wine as you propoſe, there are no other ways but thoſe,
Which are below in order plac'd, and had with jingling rhime been grac'd,
Would they not too much paper waſte: beſides, I'm now, ſir, in great haſte.

Beſt	10	11	12	13	14	15	16	17	18	19	20	quarts at 32*d.* each
Mean	44	40	36	32	28	24	20	16	12	8	4	quarts at 20*d.* each
Worſt	2	5	8	11	14	17	20	23	26	29	32	quarts at 16*d.* each

Being

* *Solution of* QUESTION 6. The number of terms being 64, the ratio 2, and the firſt term 1; the ſum of all the terms of the ſeries will be $\frac{2^{64}-1}{2-1} \times 1 = 2^{64} - 1 = 18446744073709551615$ for the number of grains of wheat; which being divided by $10000 \times 64 = 640000$ the number of grains in a buſhel, we have 28823037615171·1743984375 for the number of buſhels; the value of which at 5*s.* each is 7205759403792·79 &c. *l.* and the double of this number will be the weight in *cwts.* then the value divided by 1000, and the weight by 2000, give each 7205759403·79 &c. for the number of horſe or ſhip loads required.

† QUESTION 7. This queſtion is to find three numbers, of which two ſhall be equal to each other, and each double of the third, and whoſe continual product ſhall be (29659·5) 340·5 leſs than 30000: or, to find two numbers, the one double the other, and the leſs multiplied by the ſquare of the greater ſhall produce 29659·5: or, to find a number, the half of whoſe cube ſhall be 29659·5; or its whole cube 59319; and conſequently that number muſt be $\sqrt[3]{59319} = 39 =$ the age of each of the elder; and conſequently $19\frac{1}{2}$ is that of the youngeſt.

Being eleven anſwers in whole numbers, which are all that can be found to ſell 56 quarts, at 22*d.* a quart.*

Solution of queſtion 9.

How to divide the grinding-ſtone	1ſt.	4·4508
Which ſev'n men grind down one by one?	2d.	4·8400
Look in the margin, and you'll find	3d.	5·3535
What each man for his part muſt grind.	4th.	6·0765
(I mean, what each man for his ſhare	5th.	7·2079
Muſt grind of the diameter:)	6th.	9·3935
Which being added all in one	7th.	22·6778
Do make up the firſt given ſum.†		60 Inches.

Solution of queſtion 10.

If the learn'd Ricciolus believed may be
When he tells you, reciprocal, pendulums be
To each others length, as their ſquares of vibration
Made up in the ſame time (without variation,)

Then

* QUESTION 8. Putting x, y, and z for the number of quarts of the beſt, middle, and worſt ſort, reſpectively; then $x + y + z = 56$, and $32x + 20y + 16z = 22 \times 56 = 1232$; hence $z = 3x - 28$, and $y = 84 - 4x$. Now x muſt be ſuch a whole number as will make both $3x - 28$ and $(84 - 4x$ or) $21 - x$ whole numbers; from the latter of theſe two equations, it appears that the greateſt value of x is 20; and from the former, that its leaſt value is 10: ſo that x may be any number from 10 to 20 incluſive; and by ſubſtituting every number from 10 to 20 for x, in the two equations $z = 3x - 28$, $y = 84 - 4x$, we obtain theſe eleven anſwers in whole numbers; viz.

$x =$ 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, quarts at 32*d.* each.
$y =$ 44, 40, 36, 32, 28, 24, 20, 16, 12, 8, 4, quarts at 20*d.* each.
$z =$ 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, quarts at 16*d.* each.

† QUESTION 9. This queſtion is to divide a circle, of 60 inches diameter, into 7 equal parts, or rings, bounded by concentric circles; of which the ſolution will be thus.—The whole circle, and each inner circle, after the ſeveral preceding rings are ground off, muſt be to each other, by the queſtion, as the numbers 7, 6, 5, 4, 3, 2, 1; but circles are as the ſquares of their diameters; therefore the diameters of thoſe circles will be to one another as $\sqrt{7}$, $\sqrt{6}$, $\sqrt{5}$, $\sqrt{4}$, $\sqrt{3}$, $\sqrt{2}$, $\sqrt{1}$: but the greateſt diameter is 60 or $60\sqrt{\frac{7}{7}}$; therefore, by proportioning, all the other diameters will come out thus, $60\sqrt{\frac{6}{7}}$, $60\sqrt{\frac{5}{7}}$, $60\sqrt{\frac{4}{7}}$, $60\sqrt{\frac{3}{7}}$, $60\sqrt{\frac{2}{7}}$, $60\sqrt{\frac{1}{7}}$: Now the laſt of theſe is the diameter of the laſt perſon's ſhare, and the difference between every two adjacent terms being taken, will give the double breadth of the rings, or the parts of the whole diameter to be ground off by the other perſons; viz.

Then fifty two inches, six cents, something o'er
Will answer this question: so provide for some more.
i. e. 52·06303991625185108271 being the cube-root to 20 Decimals.* Every

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$$60\sqrt{\tfrac{7}{7}} - 60\sqrt{\tfrac{6}{7}} = \frac{\sqrt{7}-\sqrt{6}}{\sqrt{7}} \times 60 = 4{\cdot}450794 \text{ the 1st person's share}$$

$$60\sqrt{\tfrac{6}{7}} - 60\sqrt{\tfrac{5}{7}} = \frac{\sqrt{6}-\sqrt{5}}{\sqrt{7}} \times 60 = 4{\cdot}839951 \text{ the 2d}$$

$$60\sqrt{\tfrac{5}{7}} - 60\sqrt{\tfrac{4}{7}} = \frac{\sqrt{5}-\sqrt{4}}{\sqrt{7}} \times 60 = 5{\cdot}353518 \text{ the 3d}$$

$$60\sqrt{\tfrac{4}{7}} - 60\sqrt{\tfrac{3}{7}} = \frac{\sqrt{4}-\sqrt{3}}{\sqrt{7}} \times 60 = 6{\cdot}076516 \text{ the 4th}$$

$$60\sqrt{\tfrac{3}{7}} - 60\sqrt{\tfrac{2}{7}} = \frac{\sqrt{3}-\sqrt{2}}{\sqrt{7}} \times 60 = 7{\cdot}207871 \text{ the 5th}$$

$$60\sqrt{\tfrac{2}{7}} - 60\sqrt{\tfrac{1}{7}} = \frac{\sqrt{2}-\sqrt{1}}{\sqrt{7}} \times 60 = 9{\cdot}393480 \text{ the 6th}$$

$$60\sqrt{\tfrac{1}{7}} - 60\sqrt{\tfrac{0}{7}} = \frac{1}{\sqrt{7}} \times 60 = 22{\cdot}677870 \text{ the 7th}$$

the sum of them all is 60·000000 the whole diameter.

The CONSTRUCTION will be thus.—Divide the radius *A B* of the given circle into 7 equal parts; and at the points of division erect perpendiculars meeting the circle, described on the diameter *A B*, in *D*, *F*, *H*, *K*, *M*, *O*; then with the center *A*, and radiuses *A O*, *A M*, *A K*, &c. circles being described, the thing is done.—For, by the nature of the circle, the squares of the chords or radiuses *A O*, *A M*, *A K*, &c. are as the versed sines *A N*, *A L*, *A I*, &c.

SCHOLIUM. It is evident that the above method of calculation and construction will both hold true also when the shares are unequal in any proportion; by using the respective proportional numbers in the former, and dividing the radius *A B* in the same proportion in the latter.

* QUESTION 10. Since the lengths of different pendulums are to each other reciprocally as the squares of their vibrations made in the same time; we shall have, putting x for the length required, $x : 39{\cdot}2 :: 60^2 = 3600 : x\,x$; hence $x^3 = 3600 \times 39{\cdot}2$, and

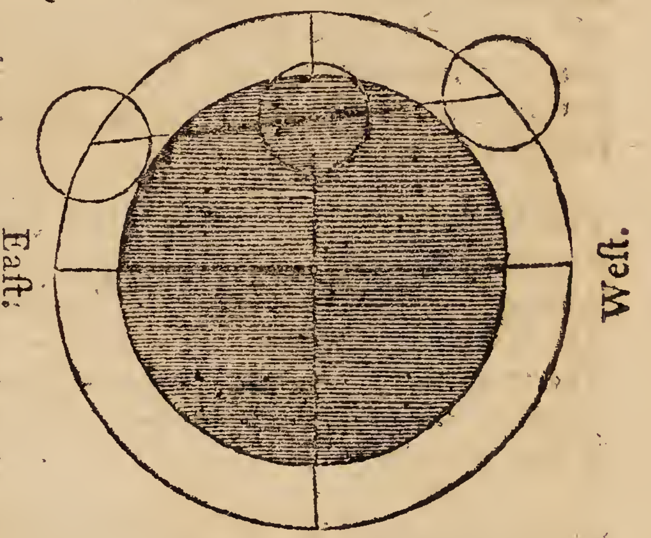
$$= \sqrt[3]{3600 \times 39{\cdot}2} = \sqrt[3]{141120} = 52{\cdot}06304 \text{ inches, nearly.}$$

Every one of these questions were answer'd by Mrs Mary and Mrs Anne Wright, before named; and by Mr Tho. Markham, of King's-lyn (who answer'd the 10th qu.) four of 'em were answer'd by Mr Fr. Walker, of Lyn-regis, Mr Hen. Beighton of Griff. Mr Amos Fish. The 6th, 9th, and 10th, were answer'd by Mr John Richards, Mr Rob. Salter, of Topsham; and Mr Abr. Symmonds, Mr Hen. Carter, Mr John Boswell, Mr John Mark, and Mr Rob. Whittle, answer'd one or more of them.

The eclipses of this year.

The two great lights of heaven, the sun and moon, will each this year be twice eclipsed.

North.



South.

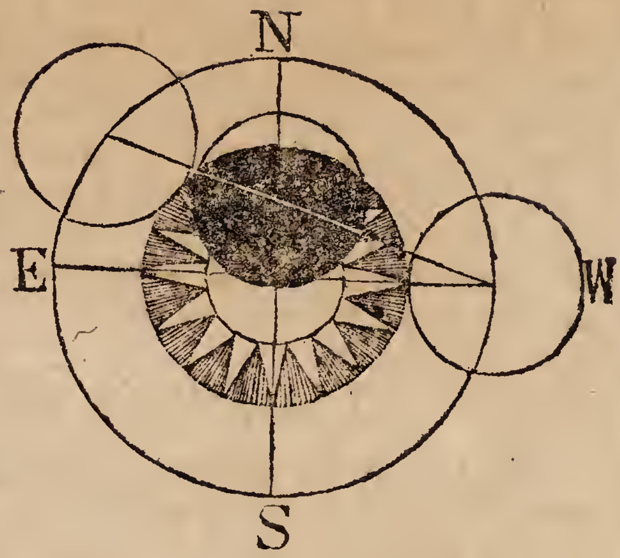
The first is an eclipse of the moon upon the second day of february; being candlemas-day, betwixt the hours of ten and eleven at night, and, if the air be clear, will be visible to us: near ten parts of the twelve of the moon's diameter will be obscured, by the shadow of the earth, on the south part of her body, according to the type here in the margin.

	h.	m.	s.	
To the inhabitants of the city of Coventry the beginning of this eclipse will be at	8	54	58	*p. m.*
The true opposition is at — —	10	16	37	
The middle of the greatest obscuration at	10	21	41	
The end of the eclipse at — — —	11	48	24	
Total duration will be — —	2	53	26	
The digits eclipsed — — —	9	56	43	south.

		m.	s.	
Latitude of the moon at the	beginning	38	48	north descen.*
	end	29	19	

The

* This eclipse was observed by Mr *H. Cressener* at *Streatham*, about 6 miles almost directly south of London, with a very good 8 foot telescope, the time by his clock being accurately corrected from Mr Flamstead's observations. He says that, the time of the end, (which was what alone the want of a proper apparatus, and a favourable sky, would give me leave accurately to determine) I found to



The second eclipse is of the sun, upon feb. 17, near 1 in the afternoon, and will (if the air be clear) appear to us in England, a considerable eclipse; for more than two third parts of the sun's body will be darkened, on the north part: (see the type in the margin.) It will be a great and central eclipse in divers parts of the world, but by reason the sun's diameter exceeds that of the moon, there will appear a bright circle of the body of the sun encompassing the moon on all parts (as it did at Rome on the 9th of April, 1576.)

	h.	m.	s.	
The begining of this eclipse, to the inhabitants of the city of Coventry, will be at	11	12	17	mane.
The greatest obscuration at — — —	0	42	58	*p. m.*
The visible conjunction at —— ——	0	45	11	*p. m.*
The end at —— —— ——	2	10	18	*p. m.*
Total duration is —— ——	2	58	1	
Digits eclipsed —— ——	8	8	36	north

		m.	s.		
Moon's latitude seen at the	beginning	0	17	south	ascend.
	end	16	57	north	ascend.

The third will be an eclipse of the moon, on the 19th day of july, between 9 and 10 a clock in the morning, therefore not visible to us: she will be 9 digits 13 min. darkened.

The last is an eclipse of the sun, on august 13, near 6 of the clock

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to be the same (with but a very inconsiderable difference) which the calculation, according to Sir Isaac Newton's admirable theory, promised me to expect.

He then puts down the calculations at large, both according to Sir Isaac's theory, and that of Mr Horrox; the result of which is that he finds

	h.	m.	s.
The end of the eclipse by the moon's place from Sir Isaac Newton's theory — —	12	2	0
The end by Horrox's theory — — — —	12	11	8
The end by observation — — —	12	1	30

The error therefore of Sir Isaac's theory is, by this observation, but half a minute, or none; of Horrox's system, nine minutes and a half.

clock in the afternoon: and though the ſun be then, to us in Great Britain, an hour high, yet the moon's ſouth latitude being great, and being increaſed by her ſouth parallax, doth depreſs her too low, as to interpoſe between the ſun and us, or indeed of any part of Europe. But in the ſouthern parts, it will be both total and central, and formidable to behold and in the latitude of 6 deg. 56 min. ſouth, and longitude 138 deg. 3 min. weſt from Coventry. This eclipſe begins at ſun riſing, in lat. 30 deg. 13 min. S. and long. 151 deg. 54 min. weſt from Coventry he will be centrally eclipſed at ſun riſing. In lat. 41 deg. 14 min ſ. and long. 105 deg. 59 w. from Coventry, he will be centrally eclipſed in the nonageſim. deg. in 76 54 ſ. and long. 64 57 w. from Coventry, he will be centrally eclipſed at ſun ſetting: and in lat. 57 26 ſ. and long. 148 w. from Coventry the eclipſe ends at ſun ſetting.

Some geographical paradoxes propoſed to the ingenious, to be ſolved againſt next year.

1. THERE are two remarkable places in the globe of the earth, in which there is only one day and one night throughout the whole year.

2. There are alſo ſome places on the earth, in which it is neither day nor night at a certain time of the year, for the ſpace of 24 hours.

3. There is a certain place of the earth, at which, if two men ſhould chance to meet, one would ſtand upright upon the ſoles of the other's feet, and neither of them ſhould feel the other's weight, and yet both ſhould retain their natural poſture.

4. There is a certain place of the earth, where a fire being made, neither flame nor ſmoke would aſcend, but move circularly about the fire. Moreover, if in that place one ſhould fix a ſmooth or plain table without any ledges whatſoever, and pour thereon a large quantity of water, not one drop thereof could run over the ſaid table, but would raiſe it ſelf up in a large heap.

5. There are three remarkable places on the continent of Europe, that lie under three different meridians, and yet all agree both in longitude and latitude,

6. There is a certain iſland in the Ægæon ſea, upon which, if two children were brought forth at the ſame inſtant of time, and living together for ſeveral years, ſhould both expire on the ſame day, yea, at the ſame hour and minute of that day, yet the life of the one would ſurpaſs the life of the other by divers months.

New

New Questions.

I *Question* 11.

A man being aſked what caſh he'd in ſtore?
Reply'd, I have three ſorts of coin, and no more.
I have ſix-pences, ſhillings, half crowns; now to ſhew
The whole ſum that I have, by this means you may know:
If the ſhillings and ſix-pences both you do join
In one ſum, they will make juſt four hundred and nine:
If the ſhillings and half crowns together you count,
The number of both you will find to amount
To one thouſand, two hundred, fifty and four,
(Which clears up the caſe ſomething more than before.)
But if you from the half crowns and ſix-pences take
Four times ten, aud twice one, the remainder will make
One thouſand, one hundred and three. Now from hence
You may tell what I have in pounds, ſhillings and pence.

II *Question* 12.

A gentleman was by agreement to pay
One thouſand pounds juſt, and no more;
And he had none other but two ſorts of gold,
Which were * guineas and † luidores.
How many of each muſt he give to defray
His ſaid debt, and how many ways might he pay
This ſaid ſum by theſe two only coyns, tell me, pray?

* *Of* 21 *s.* 6*d.*
† *Of* 17 *s.*

III *Question* 13.

A farmer with a plowman doth agree.
That thirty days his ſervant he ſhould be.
Each day he wrought, the farmer is to pay
Him ſixteen pence; but when he is away,
Five groats he is for each day to abate:
The time expir'd, they their accompts do ſtate,
Whereby the maſter nothing is to give,
Nor has the ſervant any to receive.
How many days he wrought I do demand,
And how many he play'd I'd underſtand?

IV *Question* 14.

In the midſt of a meadow well ſtored with graſs,
I took juſt an acre to tether my horſe:
How long muſt the cord be, that feeding all round,
He mayn't graze leſs nor more than his acre of ground?

V *Question* 15.

A country ſpark addreſt a charming ſhe,
In whom all lovely features did agree:
But he not ſkill'd i'th' art (you may preſage,)
Was too ſolicitous to know her age.

The

The lady ſmil'd at this prepoſt'rous rule
Of courtſhip: but to ſatisfy the fool,
Made him this anſwer with a gen'rous air
(A lofty charm peculiar to the fair,)
" My age is that, if multiply'd by three,
" And two ſev'nths of that product trebbl'd be,
" The ſquare-root of two ninths of that is four:
" And now farewel——I'll never ſee you more.
" Your fond impertinence has caus'd this rage:
" 'Tis clowniſh ſure to aſk a woman's age.
So you're deſir'd t' aſſiſt him, or perchance
The ſpark muſt ſtill remain in ignorance.

Queſtion 16, by way of letter.

London, May the firſt, 17 hundred and 9.

Dear friend,
I make bold for to ſend you a line
T' inform you what hapt to me this very day:
As I paſs'd with ſome friends thro' cheapſide, in our way
We were viewing Bow-ſteeple, ſays a ſpark that ſtood by,
Can you tell, ſir, by art, how many feet that is high?
" I'll lay you I can, ſir, a piece to be ſpent:
" 'Tis done, quoth the ſpark: I reply'd, " I'm content.
We laid down our money. The ſun ſhining plain,
I meaſur'd the ſhadow, which I found to contain
Two hundred fifty three feet, half a quarter,
And the clock juſt ſtruck twelve as I finiſh'd the matter.
Now (good ſir) inform me, how high is the ſteeple?
For you can't beat it into my head with a beetle
How it is to be done:——Were the wager to find, Sir,
A pritty plump girl, or a good glaſs of wine, ſir,
I think I could do it as well as the beſt;
But theſe crabbed hard numbers I ne'er could digeſt.
Fail me not in this pinch, ſir, whatever you do,
If you ſhould, my dear money away I ſhall throw:
Beſides, all my friends, ſir, will laugh at me too.

1711.

Anſwers to the geographical paradoxes propounded in the laſt year's diary.

Solution of Paradox 1.

The places lie under the two poles,

Solution of Paradox 2.

The places muſt be 90 degrees from the ſun when he is in or near the tropicks. Thus, if the ſun is in the tropick of capricorn, the places then will be under the artic-circle, or rather 15 minutes (being the ſemediameter of the ſun) more north, for then it is day, becauſe the ſun is below the horizon: nor is it night, becauſe by the refraction of the atmoſphere the ſun to the inhabitants of that place will ſeem to be really riſen. The reaſon of ſuch refraction I gave you in my diary of 1709.

Solution of Paradox 3 *and* 4.

Is the center of the earth.

Solution of Paradox 5.

By Mr Robert Wilſon, to this effect, viz. Divers geographers begin their firſt meridians at divers places. Thus Ptolemy at Cape Verd, (formerly one of the fortunate iſlands.) Mercator, at St Michael's in the Azores. Blaew, at Teneriff in the canary-iſlands, &c. Now if you take (under the ſame lat.) 3 places (ſuppoſe 10 degrees) from each of theſe firſt meridians, they agree all in lat. and alſo in long. from thoſe 3 reſpective places, and yet lie under 3 different meridians, in reſpect of the globe.

Solution of Paradox 6.

Mrs. Lydia Fiſher anſwers it thus: if one of the children ſails directly eaſt, and the other directly weſt, when they encompoſs the globe of the earth once (which is now eaſily done in a year) there will be two days difference in their age. And in 40 years thus ſailing, the one would be 80 days older than the other.

Mr Mark Moyle anſwers it thus: ſuppoſe the one lives within the artick Circle (where no day exceeds 24 hours) and the other goes and lives in the parallel of lat. (ſuppoſe of 73) deg. 20 min. where the day is 3 months long. and then returns, and both die; the one will be three months older than the other——Theſe were anſwer'd alſo by Mr Leadbetter, Mr. John Senhouſe, Mr. Will. Davenport.

Solu-

Solutions to the last year's questions.

*I. *Question* 11. *answered by Mr.* Tho. Gosling.

The answer will be, as sure as you're alive,
Of half crowns nine hundred ninety and five,
Of shillings two hundred fifty and nine,
Of sixpences sev'n score and ten (very fine:)
Which added together, the whole comes from thence
To one hundred forty one pounds, eighteen pence.

i. e. 995 half crowns, 259 shillings, 150 sixpences, in all 141 l. 1 s. 6 d.

†II. *Question* 12. *answered by Mr.* John Boswel.

To pay the debt as you propose,
There are no other way than those
Which here below doth plain appear,
In number sev'n and twenty are.

Guineas—32. 66. 100. 134, &c. by adding always 34.
Lewidores—1136. 1093. 1050. 1007, &c. by substr. always 43
will give 27 answers, each two sums making 1000 l.

Question

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* I. QUESTION 11. *solved.*

The meaning of this question is that the sum of the shillings and sixpences is 409, the sum of the shillings and half-crowns is 1254, and the sum of the sixpences and half-crowns 1145; to find the number of each. That is, having given the sums of every two of three numbers, to find the numbers.

Put $x =$ the number of sixpences, $y =$ the shillings, and $z =$ the half-crowns. Then, by the question, $x + y = 409$, $y + z = 1254$, and $x + z = 1145$. The sum of the first and third, is $2x + y + z = 1554$, from which taking the second, we have $2x = 300$; hence $x = 150$, $y = 409 - x = 259$, and $z = 1145 - x = 995$. And the sum of these all together amounts to 141 *l.* 1 *s.* 6 *d.*

† II. QUESTION 12. *solved.*

Put x for the number of guineas, and y for that of the louis-d'ors. Then will $43x + 34y$ be $= (1000 \times 40 =)\ 40000$; hence $y = \frac{40000 - 43x}{34} =$ (by dividing) $1176 - x - \frac{9x - 16}{34}$; consequently $\frac{9x - 16}{34} =$ a whole number, as also 4 times the same, *viz.* $\frac{36x - 64}{34} = \frac{18x - 32}{17} =$ (by dividing) $x - 2 + \frac{x + 2}{17}$; hence $\frac{x + 2}{17} =$ a whole number $= p$; then $x = 17p - 2$,

* III. *Question* 13. *answered.*

That lazy drone, who squander'd away,
Thirteen days, and one third, in sleep and play,
In thirty days (for all he nothing got)
Deserv'd to have his bones broke, for an idle sot.
i. e. He work'd 16 days 8 hours, and play'd 13 days 4 hours.

† IV. *Question* 14. *answered by Mr.* Nat. Browne.

If you be dispos'd, sir, to tether your horse
In a meadow that's very well stored with grass,
That just he may graze up an acre of ground,
The length of the cord may hereunder be found.
viz. 39 Yards. 2507375.

‡ V. *Question* 15. *answered by Mr.* John Ford.

Young maids oft speak their minds with words so dark,
That leaves a doubtful meaning on their spark;
Else she might surely without words so plenty,
As well have said her age was eight and twenty.

Question

This written for it in the expression $y = \frac{40000 - 43x}{34}$, gives $y = 1179 - 21\frac{1}{2}p$; consequently $p =$ any even number $=$ (suppose) $2n$; then $y = 1179 - 43n$, and $x = 34n - 2$; where n is any integer number.

Taking successively the numbers 1, 2, 3, 4, &c. for n, we have
$x =$ 32, 66, 100, 134, 168, 202, 236, 270, 304, &c.
$y =$ 1136, 1093, 1050, 1007, 964, 921, 878, 835, 792, &c.

* III. QUESTION 13. *solved.* Since the two products of each number of days by their respective prices are equal to each other, it follows that the said number of days will be reciprocally as the prices; but the prices are as 20 to 16, or as 5 to 4, whose sum is 9, and the whole number of days is 30; whence 9 : 30 or as 3 : 10
$:: \begin{cases} 5 : 16\frac{2}{3} \text{ days worked.} \\ 4 : 13\frac{1}{3} \text{ days idled.} \end{cases}$

† IV. QUESTION 14. *solved.* The number of square yards in an arce being 4840, and a circle being equal to 3·14159 &c. drawn into the square of the radius; therefore $\frac{4840}{3\cdot14159 \text{ \&c.}} =$ the square of the radius, and consequently the radius itself or length of the chord will be $\sqrt{\frac{4840}{3\cdot14159 \text{ \&c.}}} = 39\cdot25073$ yards.

‡ V. QUESTION 15. *solved.* Put x for the lady's age. Then, by the question, $\sqrt{3x \times \frac{2}{7} \times 3 \times \frac{2}{9}} = \sqrt{\frac{36x}{63}} = 4$; hence $x = \frac{16 \times 63}{36} = \frac{16 \times 7}{4} = 4 \times 7 = 28.$

* *Question* 16. *being the Prize Question, answered by Mrs.* Mary Wright, *to whom I presented the* 12 *diaries, according to my promise. I will give it you in her own words:*

May 1, 1709.	°	″	‴
Sun's longitude, from its ingress into aries —	51	28	0
Oblique angle of the ecliptick and equator —	23	29	0
Thence the declination that day — —	18	9	45
Consequently its merid. altitude in lat. 51° 32′.	56	37	45
The complement thereof to 90 is — —	33	22	15

Then as the sine of the angle 33°. 22′. 15″.
To the base 253. 125 feet,
So is the sine of the angle 56. 37. 45.
To the perpendicular 384. 307 feet the height of the steeple.

☞ Note, The true heighth of Bow steeple is 225 feet, for which at first I had proportioned the length of the shadow, but upon second thoughts I alter'd it, for fear some, who had read its heighth in history, should claim the reward, without having art enough to investigate it by trigonometry.

The answer to the person that sent the 16*th question.*

Sir, Yours I received, and finding you are
A pleasant companion, and kind to the fair,
I thought myself bound to assist you in this;
When to London I come you won't take it amiss,
If I give you the trouble to shew me your skill
In choosing a bottle, or a fair one that will.
To save then you coin, and prevent your friends laughter,
Three hundred eighty four feet and a quarter
Is the height of the steeple, within a small matter.

I received divers other answers in verse, from divers other persons, but have not yet room to repeat them.

The

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* VI. PRIZE QUESTION 16. *solved.*

This solution, at length, will be thus:

The sun's longitude being supposed 51° 28′, and the angle made by the equator and ecliptic 23° 29′; by right-angled spherical triangles, as radius : sine of 51° 28′ :: sine 23° 29′ : sine 18° 9′ 45″ the declination for the time; to which adding 38° 28′ the complement of the latitude, there results 56° 37′ 45″ for the meridian altitude that day. Then, by right-angled plane triangles, the height of the steeple will be found by Mrs. Wright's proportion above, or rather thus, as radius : tang. 56° 37′ 45″ :: $253\frac{1}{8}$: 384·31 the steeple's height.

The eclipſes of this year 1711.

Six times this year will the two great lights of heaven be eclipſed, namely four times the ſun, and twice the moon.

The firſt is of the ſun, on the 7th of january, 3 quarters of an hour after 9 at night; and, tho' inviſible to us, about 3 deg. eaſtward in longitude from Coventry (where it is greateſt) the ſun will ſet about 3 digits eclipſed, on the ſouth ſide of it.

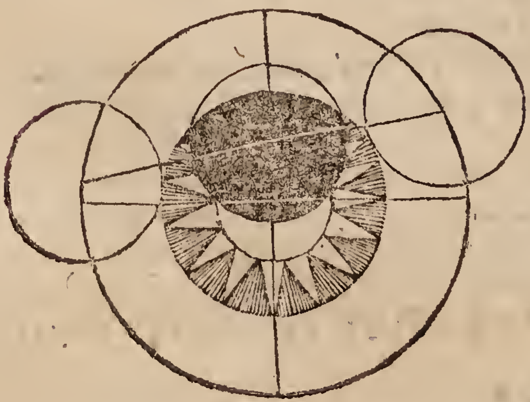
The ſecond is of the moon, a great and total eclipſe on 23d of january, near noon, and ſo inviſible to us; but will be viſible near the meridian of our antipodes. It begins at Coventry at 27 min. 29 ſec. after 10 in the morning; the immerſion is at 26 min. 30 ſec. after 11; the middle at 13 min., 10 ſec. afternoon; the true oppoſition at 14 min. 24 ſec. afternoon; the emerſion at 59 min. 51 ſec. afternoon: the end at 58 min. 52 ſec. after 1. The total duration 3 hours 31 min. 23 ſec. digits eclipſed 19 and near a quarter.

The third is a ſmall eclipſe of the ſun, on the 6th of february at 1 ho. 11 min. 56 ſec. in the afternoon, but cannot be ſeen by reaſon of the great north latitude of the moon, except under the artick circle, where it is moſt conſpicuous, and about 78 deg. weſtward in long. from Coventry; at ſun-riſing, the ſouth limb of the moon will touch the northern limb of the ſun a little more than a quarter of a digit, or the 48th part of the ſun's diameter, and therefore will hardly be perceptible.

The fourth will be an eclipſe of the ſun, on wedneſday the 4th of july, near 7 in the afternoon; and, if the air be clear, two third parts of the ſun's diameter will be ſeen to be darkened on the north ſide.

	h.	m.	s	
The beginning is at	7	3	46	p.m.
The viſible conjunction	7	53	51	p.m.
The greateſt obſcuration	7	55	52	p.m.
The end	8	45	40	p.m.
The duration	1	41	54	
The digits eclipſed	8	35	40	

Moon's latitude ſeen at the	Beginning	12	33	Nor.
	End	4	14	Deſc.



This eclipſe, where greateſt, can be but nine digits and an half, and that at ſun-ſetting under the artick circle, and longitude about 48 deg. eaſt from us.

The

The fifth is a total eclipse of the moon on july 18, at near 6 in the afternoon, but not visible to us, because the eclipse ends 10 min. before the moon rises. The beginning is at 4 ho. 6 min. 34 sec. after noon. Immersion at 5 h. 7 m. 37 s. Middle at 5 h. 51 m. 26 s. True opposition at 5 h. 53 m. 24 s. Emersion at 6 h. 35 m. 15 s. The end at 7 h. 36 m. 18 s. Duration 3 h. 29 m. 44 s. Digits eclipsed 17 and an half.

The last is of the sun on the 28th of December at 9 h. 39 m. 53 s. in the morning, but by reason of the moon's south lat. augmented by her south parallax, it cannot be seen by us, altho' the sun is above the horizon, but will be both total and central in the southern parts of the world.

Two geographical questions proposed against next year.

Question 1.

In what degree of latitude
  Does that soft female dwell,
Who upon certain days might view,
  If she observeth well,
The morning sun on th' self same point
  Of compass twice to be,
Likewise his evening azimuth
  Twice in the same degree.
Tell me sweet english ladies, for you are
Than her more charming far, and far more fair.

Question 2.

In the Atlantick ocean from our shore
Distant five hundred leagues, or little more,
Lies the canary isles, blest with good air,
Sweet whistling birds, rich wines beyond compare.
A mountain, the world's wonder's situate there,
One of the highest in this earthly sphere:
By us 'tis call'd the teneriffa's pike;
Whose lofty head i'th' atmosphere's so high,
That it surmounts all grosser clouds o'th' sky.
Three degrees and an half, you may it ken,
Or, (what's the same) two hundred miles and ten;
For the refraction angle, you may make
Allowance, (what is thought but meet to take;)
Thirty five minutes just, of a degree.
Now I demand what heighth the pike must be?

New Arithmetical Questions.

I. *Question* 17.

I happen'd one ev'ning with a tinker to ſit,
Whoſe tongue ran a great deal too faſt for his wit:
He talk'd of his art with abundance of mettle;
So I aſk'd him to make me a flat-bottom kettle,
That the top and the bottom diameters be
In juſt ſuch proportion as five is to three:
Twelve inches the depth I would have, and no more,
And to hold in ale gallons ſeven leſs than a ſcore.
He promis'd to do't, and to work he ſtrait went;
But when he had done it, he found it too ſcant.
He alter'd it then, and too big he had made it,
And when it held right, the diameters fail'd it:
So that making't ſo often, too big, or too little,
The tinker at laſt had quite ſpoiled the kettle:
Yet he vows he will bring his ſaid purpoſe to paſs,
Or he'll utterly ſpoil ev'ry ounce of his braſs.
To prevent him from ruin, I pray help him out,
The diameter's length elſe he'll never find out.

II. *Question* 18, *by Mrs.* Lydia Fiſher.

What two ſums are thoſe, can any ſuppoſe,
    If added together they muſt
Make twelve-pence, be ſure, and nine halfpence more,
    (Or ſixteen-pence-halfpenny juſt?)
But if by diviſion you make a deciſion,
    And the greater by th' leſſer divide;
In the quotient will reſt ſev'n and twenty pence juſt:
    Come, ladies, this riddle decide.
And to find out theſe nnmbers without any blunders,
    Pray tell me what courſe you will take:
And if you can do it, and to the world ſhew it,
    Amends, when I meet you, I'll make.

III. *Question* 19.

Pray try your ſkill two numbers for to find,
Whoſe ſum, when added, will be juſt one ſev'nth; ($\frac{1}{7}$)
And if together they be multiply'd,
Their product's four eight hundred forty ſev'nths. ($\frac{4}{847}$)
Fractions are called numbers here, you ſee,
And your true anſwer will two fractions be.

IV. *Queſ-*

IV. *Question* 20, *by Mr.* William Hawney.

A famous general having ferv'd his king
Long time in wars, and had victorious been;
For which his fervice (with a pleafant fmile)
Afk'd of his king one farthing for each file
Of ten men in a file, which he could then
Make with a body of one hundred men.
The king confidering his brave actions paft,
And feeming modefty of his requeft;
Gave his confent: ——To what will it amount
In fterling money? Take your pen and count.

V. *Question* 21. *by Mr.* Gideon Cofier.

A gentleman, as he did ride,
Near to a pleafant common fide,
Some fhepherdeffes chanc'd to meet,
Driving their flocks, whom he did greet.
God fpeed you well; and may you be
As happy as you're fair, (quoth he:)
Profper your flocks, and may they thrive.
Tell me how many fheep you drive?
One of the damfels ftreight reply'd,
Sir, you fhall foon be fatisfy'd,
For if the flock we fhould divide
Among us equally, each fhare
Is twice the number we maids are:
But if for one of us you do
Count one fheep, for the next count two,
For the third four, for the fourth eight,
So doubling at each maid aright,
At the laft maid the fum would be
As many as the fheep you fee.

Queft. 22. *by Mr.* Amos Fifh.

From Bifcay we fail'd with a very fair gale,
Our courfe was full north, and we fpread ev'ry fail;
For the weather was curious, unclouded the fun,
And for feveral days we with pleafure did run.
But the wind coming crofs, we concluded it beft
To alter our courfe; fo we fteered full weft,
Till our diff'rence o' longitude was one degree more
Than the latitude's diff'rence we had failed before.
Now, pray fir, refolve me how far we have run,
And how far 'tis from Bifcay from whence we begun.
All the help I can give you tow'rds finding it out,
Is, that the neareft diftance when we tack't about,

To

To a ſtreight line, if drawn from the place where we be
To Biſcay, (accounting 60 miles a degree)
Is ſev'n ſcore and ten miles, as ſure as can be.

The Prize Queſtion for 1711, *that whoever firſt anſwers ſhall have a dozen diaries.*

When tir'd with bus'neſs, or perplex'd with care,
Or minded am to breathe in fragrant air,
I to my loneſome garden ſtrait retire,
To ſoothe thoſe cares, and nature's works admire.
Here rows of charming greens delight the eye,
And here a chryſtal ſtream glides gently by:
There lovely flow'rs adorn their earthy bed,
Blended with curious dyes of white and red:
But when one lovelier than the reſt I find,
It brings the charming ſex into my mind.
For of all beauties in the world we know,
A beauteous woman does the reſt out-do.
Within this place I have two lofty firs,
Which above all my trees my mind prefers.
Upright, and ſtreight, and taper to the top,
On each of which a gilded ball I've put.
Between each tree, when meaſur'd on the ground,
In a ſtreight line, juſt ſix-ſcore feet I've found.
The higher tree one hundred feet contain,
Four-ſcore the lower (both ſtand on a plain.)
Between my trees a fountain I would place,
(The better ſtill my garden for to grace)
But ſo, that from the ball o'th' top each tree
Should to my fount of equal diſtance be.
And from this fount a walk I would have made,
And with ſuch nicety of art be laid,
That as along the ſame I near or far do move,
I'd equal diſtant be from each o'th' balls above.
At this walk's end a houſe of pleaſure I
Would have ſo plac'd by art, that when I lie
Upon my couch, to meditate, or read,
Or ſometimes ſleep to eaſe my aking head,
From ball to ball, and from each ball to me,
May equal diſtance from each other be.
Come, artiſts, now revolve within your mind
How theſe things muſt be done; and then to find
How far my houſe of pleaſure plac'd muſt be
From th' fount, and from the bottom of each tree?

This queſtion, and queſt. 17. of the tinker, &c. of this diary: alſo the queſtions laſt year of the *Lady's Age*, and of *Bow Steeple*, are good patterns how an arithmetical queſ-
tion

tion ſhould be compoſed: namely, to cloathe it with ſuch delightful circumſtances, as ſhould egg us on to the ſolving the moſt uſeful part. To heighten delight, whet the imagination, and ſharpen invention all at once, to enlarge the capacity of the mind, and raiſe our pleaſure to the higheſt pitch it is capable of; and I hope the poetical artiſt will in time to come ſend me ſome ſuch queſtions as theſe.

1712.

Anſwers to the Geographical Paradoxes propounded in the laſt year's diary.

Paradox 1, *anſwered by Mr.* Hutchinſon.

Between the tropicks and the line,
  That female I can ſhew,
That twice the ſun on the ſame point,
  I'th' morn, and ev'n, may view.
And tho' our engliſh ladies charms
  Excel her far by day,
In ſilent Nox's ſoft embrace
  She's no leſs charms than they.

* *Paradox* 2, *explained by Mr.* Nat. Brown.

That famous mountain Teneriff you call,
Whoſe towring pike o'er-looks this earthly ball,
Four miles and quarter is, and ſomething higher;
A height prodigious that all men admire. (4·281)

Solutions

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* The ſolution of this paradox is only an eaſy example in plane trigonometry, in which the radius of the earth is one leg of a right-angled triangle, the ſum of the ſaid radius and height of the mountain is the hypothenuſe, and the angle included by them is equal to the degrees in the arc of the viſible diſtance. Now taking the refraction $35'$ from $3^\circ\ 30'$ leaves $2^\circ\ 55'$ for the ſaid angle, and $21600 \div \overline{2 \times 3{\cdot}14159}$ &c. $=$ 3437·747 is the earth's radius in geographical miles; then as the coſ. of $2^\circ\ 55'$: rad. or ſine of 90° :: 3437·747 : 3442·206; from which taking 3437·747, we obtain 4·459 miles for the mountain's height; which is a little different from the anſwer above given.

Solutions to the laſt year's Queſtions.

I. *Queſtion* 17, *anſwered by Mr.* Rich. Parker.*

Before the laſt chriſtmas there came to my houſe,
A jolly fine tinker, who ſeem'd very chouſe;
I aſkt him, If ſtore of good work he had got:
He reply'd, that he had; but that he like a ſot,
Undertook t'other day for a critical aſs,
" To make him a flat-bottom'd kettle of braſs,
" Whoſe wideneſs at top and at bottom ſhould be
" In the ſame proportion as five is to three,
" The depth it ſhould juſtly twelve inches contain,
" And that it ſhould hold in ale gallons thirteen.
That he try'd many ways for to bring it about,
And yet after all he could make nothing out:
Which at length it had made him ſo wondrous poor,
That work for a tinker he crys at each door;
Who had braſs, and had money enough juſt before.
The tinker's ſad ſtory did make my heart ake,
So I gave him the meaſure each wideneſs would take,
(As hereunder you'll find) for his kettle to make.
With a great deal of joy then away went my friend,
Crying, Have ye any work for a tinker to mend?
Any boles, any bellows, any pots made of mettle;
But he ne'er could endure for to hear of a kettle.

Leſſer diameter 14·6390238.
Greater diameter 24·398373.

The ingenious Mrs. *Barbara Sidway*, in anſwer to this queſtion, propoſeth another very pretty one at the ſame time.

Well, bonny brave tinker, to ſave thee from ruin,
The kind britiſh laſſes are active and doing;
Becauſe that thou art a brave fellow of mettle,
Take here the diameters both of thy kettle;
One's twenty-four inches, four-tenths, very near,
T'other fourteen, and ſixty-four cents doth appear.

Queſtion

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* I. QUESTION 17. *ſolved.*

Putting $5z$ and $3z$ for the top and bottom diameters, by page 525 Menſuration, we ſhall have ($3 \times 64zz + 4zz$ or) $196zz \times 12 \times \cdot 00023209 = 13$: hence $z = \sqrt{\dfrac{13}{196 \times 12 \times \cdot 00023209}} = 4\cdot 880057$; conſequently $3z = 14\cdot 640171$, and $5z = 24\cdot 400285$, the two diameters required.

* *Queſtion to the tinker, or his friend.*

But now if it was to hold as much again,
And carefully lengthened at its biggeſt end,
(The whole being a fruſtum cone) I would fain know
How much is the depth of that added below?

† II. *Queſtion* 18. *anſwered.*

The firſt of your numbers, without any blunders
I find to be one that is mixt,
Fifteen the whole part, according to art,
And juſt fifty one—fifty ſixths. $(15\frac{51}{56})$
Then, dear madam Fiſher, for I do not miſs here,
Denominate ſeven times eight; $(\frac{33}{56})$
Thrice eleven of theſe, you may take if you pleaſe,
So your queſtion is anſwer'd compleat.

Queſtion

---

* *Anſwer to the queſtion to the tinker, or his friend.*

If $5a$ and $3a$ be the diameters of the firſt or given fruſtum, whoſe altitude is 12, and z the altitude of the fruſtum to be added: Then, by ſimilar triangles, &c. $\frac{1}{6}z + 5a =$ the greater diameter of the part added; and ſince the two contents are equal, we ſhall have $\overline{\frac{1}{6}az + 5a}|^2 + \overline{\frac{1}{6}az + 5a} \times 5a + 25a^2 \times z = \overline{25aa + 15aa + 9aa} \times 12$, or $\overline{\frac{1}{6}z + 5}|^2 + \overline{\frac{1}{6}z + 5} \times 5 + 25 \times z = 49 \times 12 = 588$, or $z^3 + 90z^2 + 2700z = 21168$. Hence $z = 6{\cdot}3847619 =$ the height of the part to be added.

† II. QUESTION 18. *ſolved.*

Put z for the leſs number: then, by the queſtion, either $16\frac{1}{2} - z$ or $27z$ will expreſs the greater: hence $27z = 16\frac{1}{2} - z$, or $28z = \frac{33}{2}$; then $z = \frac{33}{56} =$ the leſs number, and conſequently $16\frac{1}{2} - \frac{33}{56} = 15\frac{51}{56} =$ the greater.

OTHERWISE.

Let $x =$ the leſs number; then $27x =$ the greater, and $28x = 16\frac{1}{2} = \frac{33}{2}$; hence the reſt will be as above.

OTHERWISE.

Since, as above, the numbers are in proportion as 27 to 1, and their ſum $= 16\frac{1}{2}$: hence as $28 : 16\frac{1}{2} :: \begin{cases} 1 : \frac{33}{56} = \text{the leſs number.} \\ 27 : 15\frac{51}{56} = \text{the greater.} \end{cases}$

* III. *Question* 19, *answered by* J. R. S.

These fractions I have set down below,
The answer to your nineteenth question show.

$$\frac{1}{11} \qquad \frac{4}{77}$$

† IV. *Question* 20, *answered by Mrs.* Sidway.

Great heroes deeds no poets lines express,
Nor worthy actions recompens'd in verse;
Numbers alone their merits must recount,
See here below how vast the sums amount.

$$\frac{91}{1} \times \frac{92}{2} \times \frac{93}{3} \times \frac{94}{4} \times \frac{95}{5} \times \frac{96}{6} \times \frac{97}{7} \times \frac{98}{8} \times \frac{99}{9} \times \frac{100}{10} = 17310309456440 \text{ farth.} = 18031572350\,l.\ 9\,s.\ 2\,d.$$

V. *Quest.* 21, *answered by Mr.* Alexander Weedon.

Oh happy man! what charms did you invite,
When such a knot of fair ones came in sight;
It must enlarge and elevate your soul,
And make it boundless too without controul.
To see their lovely looks, their charming mein,
Their modest blushes, as they grac'd the green;
Their shape so ravishing, that Cupid's dart
You needs must feel quite through and through your heart,
When

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* III. QUESTION 19. *solved.*

Let $\frac{1}{14} + z$ and $\frac{1}{14} - z$ express the two numbers; then $\overline{\frac{1}{14} + z} \times \overline{\frac{1}{14} - z} = \frac{1}{196} - zz = \frac{4}{847}$; hence $z = \sqrt{\frac{1}{196} - \frac{4}{847}} = \frac{3}{154}$; consequently $\frac{1}{14} + \frac{3}{154} = \frac{1}{11}$ = the greater number, and $\frac{1}{14} - \frac{3}{154} = \frac{4}{77}$ = the less number.

† IV. QUESTION 20. *solved.*

The number of variations of 10 in 100 are $\frac{100}{10} \times \frac{99}{9} \times \frac{98}{8} \times \frac{97}{7} \times \frac{96}{6} \times \frac{95}{5} \times \frac{94}{4} \times \frac{93}{3} \times \frac{92}{2} \times \frac{91}{1} = 17310309456440$ = the number of farthings = $18031572350\,l.\,9\,s.\ 2\,d.$ = the sum demanded.

When eight fair ſhepherdeſſes to your view, (8 *maids*)
Were altogether met beholding you.
Who came to feed their harmleſs flocks of ſheep,
Which daily they did on the common keep;
The number juſt one hundred twenty eight, (128 *ſheep*)
On which they did ſo diligently wait.
Which numbers both do very well agree:
The queſtion's ſolv'd as plainly you may ſee.*

Mrs. Barbara Sidway, *to Mr.* Gideon Croſier, *the propoſer.*

The ſheep were one hundred twenty eight,
The virgins, twice four, and a glorious ſight.
But honeſt maſter *Gideon Croſier*,
Upon my word you ſent a poſer:
Had not the number eaſy been, Sir,
You might have whiſtled for an anſwer.
For do but in your mind revolve,
Queſtions ſuch as this to ſolve,
This ſame equation muſt reduce,
As underneath you may peruſe,
Where (*a*) the vowel, is unknown, Sir,
Reduce it, and call me your own, Sir.

$r^a = rdaa$. Or, $r^{a-1} = daa$.

VI. *Queſtion* 22, *anſwered by the ſame.*

Sail'd north ————————	188·256 miles
Sail'd weſt ————————	248·256
Diſtance run ————————	436·512
From Biſcay to the ſhip's place	311·555

Suppoſe

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* V. QUESTION 21. *ſolved.*

If z be put to denote the number of maids; then, by the queſtion, $z \times 2z = 2zz$ will denote the number of the ſheep, and $2zz = 2^{z-1}$; hence, multiplying by 2, we have $4zz = 2^z$; and, by extracting the root, $2z = 2^{\frac{1}{2}z}$: From this equation, by trials, we eaſily find $z = 8$ = the number of maids; and then $2zz = 128$ the number of ſheep.

When the quantity of z is an integer number, it is beſt found by trials as above. But if it be ſome infinite decimal, put the above equation into logarithms, and we have $\frac{1}{2}z \times \log. 2 = \log. 2 + \log. z$, or $\cdot150515z - Z = \cdot301030$, putting $Z = \log.$ of z; then find the value of z by double poſition or the method of trial-and-error.

Suppose it plain sailing, the answer you see,
But if by Mercator, pray, what would it be?
That handsome tarpawlin I almost durst wed,
That has the true method thereof in his head.*

Answer to the Prize Question, which was first answered by Mr. Henry Beighton, *and soon after by Mrs.* Anna Wright, *Mr.* Ford, *Salt-officer of Middlewich, and divers others.*

I lately heard your curious garden nam'd,
For its exactness all o'er England fam'd:

Your

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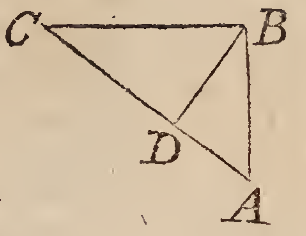
* VI. QUESTION 22. *solved.*



From the right angle B let fall the perpendicular BD: If AB represent the distance sailed north, and BC the distance west; then will AC represent the distance between *Biscay* and the place arrived at, and BD 150 miles.

Now by right-angled triangles we have

$$AC^2 = CB^2 + BA^2,$$

and $2AC \times BD = 2CB \times BA$;

hence, subtracting the second equation from the first, we have $AC^2 - 2AC \times BD = CB - 2CB \times BA + AB^2 = \overline{CB - BA}|^2$, and $AC = BD + \sqrt{BD^2 + \overline{CB - BA}^2} = 150 + \sqrt{150^2 + 60^2} = 150 + 30\sqrt{29} = 311{\cdot}554944214 =$ the distance from *Biscay*.

And, by adding the second equation to the first, we have $AC^2 + 2AC \times BD = CB^2 + 2CB \times BA + AB^2 = \overline{CB + BA}|^2$, and $CB + BA = \sqrt{\overline{AC + 2BD} \times AC} = \sqrt{611{\cdot}5549\ \&c \times 311{\cdot}5549\ \&c.} = 436{\cdot}50082 =$ the whole distance run.

Also, by adding and subtracting the difference and sum, we have CB and $BA = \frac{436{\cdot}50082 \pm 60}{2} = 248{\cdot}25041$ and $188{\cdot}25041$.

The CONSTRUCTION is evident from the above process, *viz.*

Make $AC = (BD + \sqrt{BD^2 + \overline{CB - BA}|^2} =)$ the sum of BD and the hypothenuse of a right-angled triangle whose two legs are BD and $CB - BA$: then the sum of the legs $(CB + BA)$ being equal to $(\sqrt{\overline{AC + 2BD} \times AC})$ the mean proportional between AC and $AC + 2BD$, the legs CB, BA themselves will be $=$ the half sum and difference of $CB - BA$ and the said mean proportional.

Your lofty firs, ſo ſtreight, ſo ſmooth, ſo tall,
Each of them crowned with a golden ball:
One eighty foot, yet twenty foot out-done,
By his tall fellow, towring tow'rds the ſun.
Between your trees is plac'd a fountain clear,
Nearer which ball, no mortal can declare,
A pleaſure houſe is plac'd with ſuch nice art,
That with the balls three equal lengths impart.
And if from thence you walk to th' fountain clear,
You to each ball at equal diſtance are:
The diſtance then betwixt each ball in meaſure,
Alſo betwixt each ball and th' houſe of pleaſure,
Likewiſe from th' houſe and bottom of each firr,
And from the houſe unto the fountain clear,
And from the fount to th' bottom of each tree,
The lines below, I hope, will let you ſee.

From ball to ball — — —	121 65525
From each ball to the pleaſure houſe	121 65525
From the lower tree bottom to the houſe	91 65151
From the taller tree bottom to the houſe	69 28203
From the houſe to the fountain —	52 67827
From the lower tree bottom to the fount	75
* From the higher tree bottom to the fount	45

The

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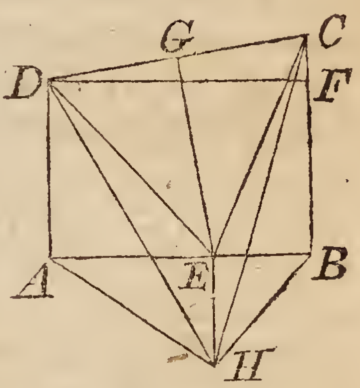
* *The* PRIZE QUESTION.



Let AD be the one tree, and BC the other. Draw CD the diſtance of the two balls. On the middle of which and perpendicular to it draw GE, and E will be the fountain. For then DE will be $=$ EC by *Eucl.* I. 4.

Alſo the required path, at the end of which ſtands the pleaſure houſe, will be a right line EH perpendicular to AB, and $=$ one leg of a right-angled triangle whoſe other leg is EA, and its hypothenuſe $AH =$ the baſe of another right-angled triangle ADH whoſe perpendicular is AD and hypothenuſe $DH = DC$.——For, becauſe of the path's continual equal diſtances from the balls, it will be the interſection of the horizontal plane and another plane perpendicular both to the line DC and the vertical plane $ABCD$, and this interſection is perpendicular to AB by *Eucl.* XI. 19.

The CALCULATION. Since $(ED^2 =)\ DA^2 + AE^2 = (EC^2 =)\ CB^2 + BE^2$; therefore, by equal ſubtraction, $BC^2 - DA^2 = AE^2 - EB^2 = AB \times \overline{AE - EB}$; and

hence

The same answered by Mr. Edward Walker.

In your fair garden garnished with flowers,
Circled with chrystal streams, and charming bowers,
Your pleasure house from the clear fount must stand
Fifty two feet, with some odd parts behind,
And from the bottom of the greatest tree,
Sixty nine, more by an half must be;
And for the rest, you here above may see.

The eclipses of this year 1712.

There will be four eclipses this year. The first is a small but visible eclipse of the moon, on january the 12th; it begins at 1 minute after 7 at night, the middle is at 52 minutes after 7, the end at 43 minutes after 8; the whole duration is 1 hour and 42 minutes, and will be about two digits and an half eclipsed on the north side.* The second eclipse is of the sun, on the 22d of june, at 10 at night, and therefore cannot be seen. The third is of the moon, the 8th of july, at 8 in the morning,

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hence $AE - EB = \frac{BC^2 - DA^2}{AB} = \frac{100^2 - 80^2}{120} = 30$: Consequently AE and $EB = \frac{AB \pm 30}{2} = \frac{120 \pm 30}{2} = 75$ and 45, the distances of the fountain from the bottoms of the two trees. And $DE = EC = \sqrt{CB^2 + BE^2} = \sqrt{100^2 + 45^2} = 5\sqrt{481} = 109{\cdot}65856099$ the distance of each ball from the fountain. Also $DH = HC = CD = \sqrt{DF^2 + FC^2} = \sqrt{120^2 + 20^2} = 20\sqrt{37} = 121{\cdot}6552506$. Hence $BH = \sqrt{HC^2 - CB^2} = \sqrt{20^2 \times 37 - 100^2} = 20\sqrt{12} = 69{\cdot}2820323 =$ the distance of the pleasure house from the foot of the taller tree. $AH = \sqrt{HD^2 - DA^2} = \sqrt{20^2 \times 37 - 80^2} = 20\sqrt{21} = 91{\cdot}651513899 =$ the distance of the same from the lower tree. And $EH = \sqrt{HB^2 - BE^2} = \sqrt{20^2 \times 12 - 45^2} = 5\sqrt{111} = 52{\cdot}67826876 =$ the length of the walk, or the distance of the pleasure house from the fountain.

* This eclipse [January 12] was observed as follows:

I. At *Greenwich* by Mr. *Flamsteed.*

He says the middle of the eclipse was at 7 h. 40 m. 50 s. by the clock, or 7 h. 34 m. correct time. At which time the chord of the eclipsed part of the moon was 24. 30: but the greatest defect on the northern side was 8. 30. The moon's diameter 30. 48.

II. At

morning, and therefore invifible. The fourth is of the fun, on the 17th of december, at 1 in the morning, and therefore can't be feen.

New Arithmetical Queftions.

I. *Queftion* 23. *The widow's cafe, by Mr.* Lewis Even.

Ingenious ladies, whom their ftars benign
Render'd their fates more happy far than mine:
Affift, I pray, fo may you never fee
Such difmal days as heav'n allotted me.
My fecond-felf, the one half of my life,
Whom to furvive yields me the greateft grief,
The fates unkind has fnatch'd away in's prime,
I for this lofs fhed tears more falt than brine;
Depriv'd of all my joys and hopes at once,
The greateft that all love could e'er advance;

I be'ng

II. At *Upminfter* by Mr. *W. Derham.*

h. m.	
6 15	A dufkifhnefs upon the N. E. fide of the moon.
6 36	A thick penumbra on the moon.
6 37	The penumbra fo denfe that it may be taken for the beginning of the eclipfe.
6 39	The eclipfe undoubtedly is begun.
8 31	End of the eclipfe is very near.
8 32	End of the eclipfe.
8 $32\frac{3}{4}$	Eclipfe is undoubtedly ended.
8 36	A penumbra is left.

III. At *Uratiflavia (Breflaw)* by *R. P. Chriftopher Heinrich.*

h. m. s.	
7 15 39	A dufkifhnefs obferved on the moon.
7 34 54	Beginning of the penumbra.
7 40 11	Beginning of thick darknefs.
7 56 3	*Aldebaran* culminated.
8 38 7	*Orion*'s weftern foot culminated.
9 11 18	*Orion*'s eaftern foot culminated.
9 38 33	End of the thick fhadow.
9 44 4	End of the penumbra.
10 9 17	*Sirius* culminated.

The folar time was meafured by a pendulum clock, and corrected by the obferved culminations of four fixed ftars. And the quantities were determined by a micrometer in the telefcope.

The fhadow through the telefcope feemed afh-coloured, bluifh and approaching to blacknefs. It began to appear above *Ariftarchus*, and then paffed over the upper part of the moon.

I be'ng with child the time my dear lay ill,
He this proviſion made by his laſt will.
T'th' child i'th' womb, if male, two parts in three
Of this his wealth he gave; one third to me.
But if by me the pow'rs above are pleas'd
The number of the fair ſhould be increas'd,
Then I was to enjoy two parts in three;
One third ſhould to my fair a fortune be.
My deareſt dies: e're long was God's decree
Made known, how he was pleas'd to deal with me:
His bleſſed pleaſure was, that at one birth
I both a ſon and daughter ſhould bring forth.
This double birth, unthought of by my dear,
Makes th' execution of the will appear
Ambiguous unto me, and therefore I
Muſt needs my ſelf to better heads apply.
Sev'n thouſand pounds my dear's eſtate is priz'd,
In this odd caſe, I crave to be advis'd,
This to divide according to the will
Betwixt us three: I pray exert your ſkill.
What ever priviledge the widows have
By force of law, moſt willingly I wave:
To lawyer for advice I'll give no fee,
My huſband's will a law ſhall be to me.

II. *Queſtion* 24, *by Mr.* Amos Fiſh.

I have holland, and muſlin, and ſcotch cloth good ſtore,
I have cambrick, you never ſaw better before:
The number of ells of each ſort I can't tell,
But the whole ſum together, I remember right well,
Was juſt thirty thouſand; nay, more I can ſhow,
The firſt and the laſt I very well know,
Be'ng multiply'd together proved to be the ſame ſum,
To which the product of muſlin and ſcotch cloth did come,
And the ſquares of the holland and cambrick when join'd;
In one ſum, will be one hundred ſixty millions you'll find.
But the number of ells that each ſort did contain,
I would willingly know, but I labour in vain,
And if you don't help, I'm afraid of my brain.
One thing I forgot, which is proper to tell,
The holland was moſt by many fair ell.

III. *Queſtion* 25, *by Mr.* Alexander Weeden.

If a ſquare piece of timber be
Exactly twelve foot long;
Three inch the ſide o'th' leſs ſquare baſe,
The greater, twenty one:

Then

Then this I very fain would know,
How many feet in all;
And what's each ſolid foot's true length,
From greater baſe to th' ſmall?

IV. *Queſtion* 26, *by Mr.* John Burnet.

Suppoſe, ſir, a buſhel be exactly round,
Whoſe depth be'ng meaſur'd eight inches is found;
If the breadth eighteen inches and an half you diſcover,
This buſhel is legal all England over.
But a workman would make one of another frame,
Sev'n inch and an half muſt be th' depth of the ſame:
Now, ſir, of what length muſt th' diameter be,
That it may with the former in meaſure agree.

V. *Queſtion* 27, *by Mr.* John Wilſon.

If to my months you ſhould add half their ſum,
And one eighth more, and then ſhould ſubtract one;
The reſidue would ſuch a number be,
As twenty one being ſquar'd, aſſuredly.

VI. *Queſtion* 28, *by Mr.* Henry Beighton.

I hired a horſe, for to viſit my dear,
(A lovely ſweet maid of complexion moſt clear:)
At three pence a mile, for the hire we agreed;
So from London to Briſtol I rid with full ſpeed,
Being miles ninety four, and it lyeth full weſt:
But when I came there my dear virgin I miſt.
For ſometime before ſhe was gone to Weſt Cheſter,
With a man, as they told me, ſhe huggl'd and kiſt, ſir:
Nay, ſo fond ſhe was of him, ſhe li't him to bed,
And for ſeveral hours there with him ſhe ſtaid.
This made me diſtracted; ſo away I ſet forth
To Cheſter, which lieth from Briſtol full north.
I whipped and ſpur'd, and I ſcoured away,
And woman! falſe woman! was all I could ſay.
But the number of miles I did ride, I can't tell,
My heart did with envy and paſſion ſo ſwell.
When I came to Weſt Cheſter, I found to my joy,
That it was her own father had took her away.
I ſtreight made propoſals to marry his daughter,
But he ſaid he'd take time for to think on the matter.
From Cheſter to London we directed our aim,
And at ſixty ſix miles we to Coventry came:
Where I preſs'd things ſo home, that we made up the match,
But to Briſtol I muſt firſt ſome writings go fetch.

(The

(The road's perpendicular to that we laſt came)
And they promis'd to ſtay till I came back again.
A young eager lover, you need not bid haſte,
When the nuptial joys he is ready to taſte.
Upon my return, we to London did go,
But the joy of our marriage tranſported me ſo,
That I never enquired the miles I did go.
Now the man for the hire of his horſe he has ſent,
And willing I am for to give him content:
But how much is due, neither him nor I know,
No more than the horſe that I rode on, I vow.
Pray, ſir, be ſo kind as to tell me the ſum,
And a bottle I'll give you when that way I come.

The Prize Queſtion, (of ten Diaries by lot) propoſed by Mr. Peter Hingeſton, *jun. (a ſcholar in Ipſwich grammar ſchool.)*

Of the regular bodies platonick, you know,
The dodecaedron twelve faces does ſhow,
That are baſes of pentangled pyramids join'd,
By their tops at the centre. Now, ſir, I pray mind:
If, as large as each pyramid's bulk will admit,
All the baſes be dug into concaves, to wit,
Into hemiſpheres, cylinders, cubes too and cones,
Into pyramids likewiſe; triangular ones,
And quadrangular alſo; of each of theſe two;
(In each ſide one of them;) ſir, can you this do?
If the matter 'tis made of does weigh, being try'd,
For each ſolid foot ſixty pounds, and the ſide
Of each pentangle eight inches be, and no more,
By geometry, what it weighs juſtly explore.

1713.

Solutions to the laſt year's Queſtions.

I. *Queſtion 23, anſwered by Mrs.* Anna Wright.

WHEN firſt the widow's mournful caſe I read,
My ſympathizing heart with grief did bleed;
Her I'll aſſiſt, ſaid I, her doubts reſolve;
Then in my mind I did the caſe revolve:
Where ſoon the widow's ſhare by will I found,
To be no leſs than juſt two thouſand pound;
One thouſand pounds left to her daughter dear,
And juſt four thouſand to her ſon and heir.

I had

I had a great many excellent anſwers to this queſtion by Mr. *Moyle*, Mr. *John Wilſon*, Mr. *Newbold*, *Francius*, Mr. *Abel Ragg*, and others; but having ſo little room to ſpare, my fair reader, I hope, will pardon me if I inſert but one more ſolution of this queſtion, and one only of each of the enſuing.

* *The ſame Queſtion anſwered by Mr.* James Cole.

Diſpel thoſe clouds which hover o'er your head,
Since that your love, your deareſt love is dead;
To weep, and mourn, alaſs 'tis all in vain!
For you can never bring him back again!
If whilſt on earth, he walk'd in vertue's ways,
He now with joy ſings his redeemer's praiſe;
Which joy ſhall laſt beyond the reach or power
Of time, with's teeth of iron, to devour.
With winged ſpeed he's gone from cares below,
T' a place which mortals are too frail to know.
Therefore with comforts calm your troubl'd mind,
To think your huſband left thoſe cares behind.
As for the execution of his will,
And how the ſame you rightly may fulfil,
Look underneath, and there you'll plainly ſee,
The manner how th' eſtate muſt parted be.
(*Here followed the anſwer, being the ſame as above.*

II. *Queſtion* 24, *by Mr.* John Newbold.

Good Mr. *Fiſher*, I am your well wiſher,
  If draper or ſcotchman you be;
And have ſent you the anſwer, as plain as I can, ſir,
  Tho' unſkill'd in the commodity.
In th' holland I'm right, and the cambrick white,
  But the other are dubious, whether
Are the greater o'th' two, ſo I leave it to you,
  Till time will permit you to meaſure.

Twelve

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* I. QUESTION 23. *ſolved.*

By the *will*, the mother's ſhare was to be the double of the daughter's, and the ſon's the double of the mother's; wherefore they will be in proportion as the numbers 1, 2, and 4; and the ſum of theſe numbers being 7, it appears that the ſhares will be $\frac{1}{7}$, $\frac{2}{7}$, and $\frac{4}{7}$ of the whole eſtate: *viz.*

$\frac{1}{7}$ of 7000*l.* = 1000*l.* = the daughter's ſhare.

$\frac{2}{7}$ of 7000*l.* = 2000*l.* = the mother's ſhare.

$\frac{4}{7}$ of 7000*l.* = 4000*l.* = the ſon's ſhare.

Twelve thouſand the firſt, four thouſand the laſt,
The other two are * eight and * ſix; (* *i. e.* 8000 & 6000)
But the number to each are out of my reach,
There's no certainty what to affix.†

Holland 12000, muſlin 8000, ſcotch cloth 6000, and cambrick 4000.

‡ III. *Queſtion* 25, *anſwered by* Francius.

The feet the timber does contain, below you plain may find:
Likewiſe each foot's true length is ſhewn, according to your (mind.

The firſt ſolid foot's length is 4·0136, the ſecond is 4·2208, the 3d is 4·4552, the 4th is 4·7272, the 5th is 5·0448, the 6th is 5·42, the 7th is 5·876, the 8th is 6·4408, the 9th is 7·1656, the 10th is 8·1352, the 11th is 9·5208, the 12th is 11·7096, the 13th is 15·8776, the 14th is 29·4824, and the ·25 is 21·9104.

IV. *Queſ-*

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† II. QUESTION 24. *ſolved.*

This queſtion is unlimited, for there are four unknown quantities, and only three conditions. And, to determine the reſt, one of them muſt be aſſumed.

Put z, y, x, v for the four quantities; then

$$z + y + x + v = 30000 = a,$$
$$zv = yx,$$
$$zz + vv = 160000000 = b.$$

To and from the third adding and ſubtracting the double of the firſt, we have $zz \pm 2zv + vv = b \pm 2xy$; hence $z \pm v = \sqrt{b \pm 2xy}$; then by ſubſtitut. in the firſt, we get $y + x + \sqrt{b + 2xy} = a$; from this is obtained $y = a - \sqrt{b + 2ax - xx}$: by aſſuming $x = 6000$, this expreſſion gives $y = 8000$. And then z and $v = \dfrac{\sqrt{b + 2xy} \pm \sqrt{b - 2xy}}{2} = 12000$ and 4000.

‡ III. QUESTION 25. *ſolved.*

By page 159 Menſuration, the ſolidity of the whole piece will be $\dfrac{21 \times 21 + 21 \times 3 + 3 \times 3}{3} \times 12 \times 12 = 24624$ inches $= 14\frac{1}{4}$ feet. And if the fruſtum be ſuppoſed to be compleated to a pyramid; then, by ſimilar triangles, as $21 - 3$ is to 21, or as 18 to 21, or as 6 to 7, ſo is 12 to 14 feet its altitude; and hence $\dfrac{21 \times 21}{3} \times 14 \times 12 = 24696$ inches $= 14{\cdot}291\frac{2}{3}$ feet $=$ the content of the whole pyramid. Whence, as ſimilar ſolids are as the cubes of their like dimenſions, we ſhall have $\sqrt[3]{14{\cdot}2916}$: $\sqrt[3]{13{\cdot}2916}$ :: 14 feet or 168 inches : $168\sqrt[3]{\dfrac{13{\cdot}2916}{14{\cdot}2916}}$ inches, and

168 —

* IV. *Question* 26, *answered by Mr.* Tho. Shepheard.

The diameter's length if the workman would know,
To please his nice fancy unto him pray shew, *(inches*
The answer that I have here placed below, *(viz.)* 19·1067.

V. *Ques-*

$$168 - 168\sqrt[3]{\frac{13{\cdot}2916}{14{\cdot}2916}} = \frac{\sqrt[3]{14{\cdot}2916} - \sqrt[3]{13{\cdot}2916}}{\sqrt[3]{14{\cdot}2916}} \times 168 =$$

$\sqrt[3]{14{\cdot}2916} - \sqrt[3]{13{\cdot}2916} \times 69{\cdot}228 =$ the altitude of the lowest or 1st foot. And in like manner all the others will be found as below.

$:\sqrt[3]{14{\cdot}2916} - \sqrt[3]{13{\cdot}2916} : \times 69{\cdot}228 =$	$4{\cdot}0134 =$	alt. of 1st foot
$:\sqrt[3]{13{\cdot}2916} - \sqrt[3]{12{\cdot}2916} : \times 69{\cdot}228 =$	$4{\cdot}2203 =$	- - - 2d
$:\sqrt[3]{12{\cdot}2916} - \sqrt[3]{11{\cdot}2916} : \times 69{\cdot}228 =$	$4{\cdot}4557 =$	- - - 3d
$:\sqrt[3]{11{\cdot}2916} - \sqrt[3]{10{\cdot}2916} : \times 69{\cdot}228 =$	$4{\cdot}7273 =$	- - - 4th
$:\sqrt[3]{10{\cdot}2916} - \sqrt[3]{9{\cdot}2916} : \times 69{\cdot}228 =$	$5{\cdot}0442 =$	- - - 5th
$:\sqrt[3]{9{\cdot}2916} - \sqrt[3]{8{\cdot}2916} : \times 69{\cdot}228 =$	$5{\cdot}4205 =$	- - - 6th
$:\sqrt[3]{8{\cdot}2916} - \sqrt[3]{7{\cdot}2916} : \times 69{\cdot}228 =$	$5{\cdot}8765 =$	- - - 7th
$:\sqrt[3]{7{\cdot}2916} - \sqrt[3]{6{\cdot}2916} : \times 69{\cdot}228 =$	$6{\cdot}4406 =$	- - - 8th
$:\sqrt[3]{6{\cdot}2916} - \sqrt[3]{5{\cdot}2916} : \times 69{\cdot}228 =$	$7{\cdot}1649 =$	- - - 9th
$:\sqrt[3]{5{\cdot}2916} - \sqrt[3]{4{\cdot}2916} : \times 69{\cdot}228 =$	$8{\cdot}1354 =$	- - - 10th
$:\sqrt[3]{4{\cdot}2916} - \sqrt[3]{3{\cdot}2916} : \times 69{\cdot}228 =$	$9{\cdot}5210 =$	- - - 11th
$:\sqrt[3]{3{\cdot}2916} - \sqrt[3]{2{\cdot}2916} : \times 69{\cdot}228 =$	$11{\cdot}7093 =$	- - - 12th
$:\sqrt[3]{2{\cdot}2916} - \sqrt[3]{1{\cdot}2916} : \times 69{\cdot}228 =$	$15{\cdot}8778 =$	- - - 13th
$:\sqrt[3]{1{\cdot}2916} - \sqrt[3]{0.2916} : \times 69{\cdot}228 =$	$29{\cdot}4827 =$	- - - 14th

the sum 122·0896 being taken from
12 feet or 144·0000 inches, we have

21·9104 = alt. of the $\frac{1}{4}$ f.

* IV. QUESTION 26. *solved.*

Since equal cylinders have their altitudes reciprocally proportional to the squares of their diameters, we shall have, As $\sqrt{7\frac{1}{2}} : \sqrt{8} :: 18\frac{1}{2} : 18\frac{1}{2}\sqrt{\frac{8}{7\frac{1}{2}}} = 18\frac{1}{2}\sqrt{\frac{16}{15}} = \frac{74\sqrt{15}}{15} = 19{\cdot}10671784$ inches = the diameter required.

* V. *Queſtion 27, anſwered by Mrs.* Mary Nelſon.

To gueſs at your parts, by the length of your time,
You're fit for the ladies, and juſt in your prime.
If any thing more in your praiſe can appear,
Engage Mr. *Tipper* to incert it next year:
But ſince I'm obliged your age to diſcover,
You're juſt twenty two years, and eight months over.

† VI. *Queſtion 28, anſwered by the ſame.*

When this charming briſk laſs, you purſued ſo faſt,
From London to Briſtol, ſo on in ſuch haſte;
At three-pence a mile, as you agreed before,
I have ſet down the anſwer exact, and no more.

Anſ. 5 *l.* 13 *s.* $2\frac{1}{4}$ *d.* *Anſwer*

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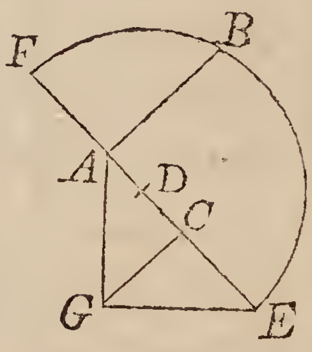
* V. QUESTION 27. *ſolved.*

This queſtion being to find a number which being added to its one-half and one-eight ſhall make 442 (one more than the ſquare of 21); or, ſince the ſum of 1, $\frac{1}{2}$, and $\frac{1}{8}$ is $\frac{13}{8}$, to find a number which multiplied by $\frac{13}{8}$ ſhall produce 442; wherefore as 13 : 8 :: 442 : $\frac{442 \times 8}{13} = 34 \times 8 = 272$ months $=$ 22 years 8 months $=$ his age.

† VI. QUESTION 28. *ſolved.*

CONSTRUCTION. Make AB, AC perpend. to each other, the former $= 94$ the diſtance between London and Briſtol, and the latter $= 66$ the diſtance between Cheſter and Coventry. Biſect AC in D, and with center D and radius DB deſcribe a circle meeting AC produced in E and F; then with the hypothenuſe AE and baſe $EG = AB$ form the right-angled triangle AEG; ſo ſhall E repreſent London, G Briſtol, A Cheſter, and C Coventry.



For, (having drawn CG) by ſimilar triangles, $GE^2 = EA \times EC = $ (by the conſtruction) $EA \times AF = AB^2$.

CALCULATION. The radius $ED = DB = \sqrt{BA^2 + AD^2} = \sqrt{94^2 + 33^2} = \sqrt{9925} = 5\sqrt{397} = 99{\cdot}62429$. Hence $CE = ED - DC = 66{\cdot}62429 =$ the diſtance from Coventry to London; $GA = \sqrt{AE^2 - EG^2} = \sqrt{\overline{AD + DE}^2 - EG^2} = \sqrt{226{\cdot}62429 \times 38{\cdot}62429} = 93{\cdot}55855$; and $GC = \frac{EG \times GA}{AE}$ or $= \sqrt{GE^2 - EC^2} = 66{\cdot}31141$. Then $GA + AE + EG + 2\,GC = 452{\cdot}80566$ miles $=$ the whole diſtance travelled; which at 3 *d.* a mile will produce 5 *l.* 13 *s.* 2 *d.* $1{\cdot}66792$ *q.*

Answer to the Tinker's Question, by Mr. Richard Parker.

If the top of the kettle be lengthened on,
(With a figure that's just like a frustum cone,)
Six inches and thirty nine cents, and no more,
Will make it to hold twice as much as before.

* *Answer to the Prize Question.*

Tho' I received seven answers to this queston, only three of them were right, (*viz.*) Mrs. *Barbara Sidway*, Mr. *Beighton*, and one more (who desired to conceal her name.) Mrs. *Sidway*'s answer was very fine, and in good verse, but so very long, I have not room to insert it: I shall therefore only set down the answer.

The dodecaedron weighs, after all the twelve cavities are cut out, $60{\cdot}6527$ pounds.

The

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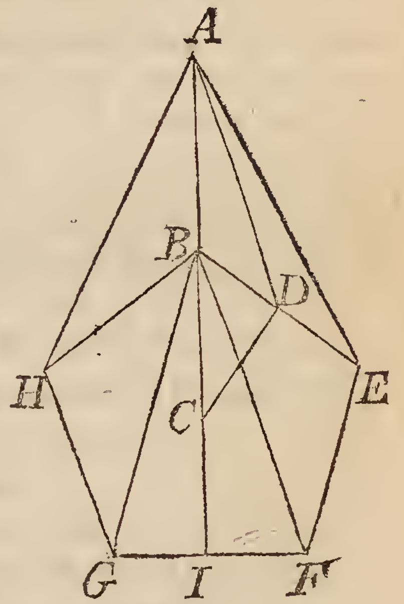
* PRIZE QUESTION *solved.*



Let $ABEFGH$ be one of the twelve pyramids constituting the dodecaedron, and C the center of its base: draw CD perpendicular to BE, and the rest of the lines as in the figure.

Putting $A = 8 = BE$ one side of the pentagon or base, by page 410 Mensuration, we have $AC = A\sqrt{\frac{25+11\sqrt{5}}{40}}$ $= 1{\cdot}113516A$; and $CD = \frac{1}{2}A \times$ tang. $54^\circ = {\cdot}68819095A =$ radius of the base of the cone. And, since the greatest inscribed cylinder is known to be $\frac{4}{9}$ of the cone, we shall have $\frac{13}{9}CD^2 \times 3{\cdot}14159$ &c. $\times \frac{1}{3}CA = 2{\cdot}14916A^2 \times \frac{1}{3}CA =$ the the cone and cylinder together.——But the greatest triangle in the pentagon is BFG, and the greatest quadrangle is $BFGH$; the sum of these two is the $\triangle\, GHB + 2\triangle\, BFG$. Now the $\triangle\, GHB = GH \times HB \times \frac{1}{2}$s. $\angle H = \frac{1}{2}A^2 \times$ s. $108^\circ = {\cdot}475528 25A^2$, and $2\triangle\, BFG = BI \times GF = A^2 \times \frac{1}{2}$ tang. $\angle BFI = A^2 \times \frac{1}{2}$tang. $72^\circ = 1{\cdot}53884175\,A^2$; the sum of these two is $2{\cdot}01437A^2 =$ the bases of the triangular and quadrangular pyramids together; and consequently their contents together will be $2{\cdot}01437A^2 \times \frac{1}{3}AC$.——Adding this to the sum of the cone and cylinder above found, we have $4{\cdot}16353A^2 \times \frac{1}{3}AC = 1{\cdot}545386A^3 =$ the sum of these four solids.

 Again,

The Eclipses of this Year.

Of four eclipses which will happen this year, only one of them will be visible. The first is an eclipse of the moon, may 28, near half an hour after 6 in the afternoon, and therefore invisible. The second is an eclipse of the sun, on the 11th of june, half an hour before midnight, and therefore invisible to us, but will be visible to our antipodes. The third is a visible eclipse of the moon on november 21. The beginning will be at Coventry 8 min. after 2 in the morning; the middle at 18 min. after 3; and the end at 23 min. after 4 in the morning. The whole duration is 2 ho. 18 min. The digits eclipsed are 5 deg. very near. Lat. of the moon in the beginning

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Again, $DA = \sqrt{AC^2 + CD^2} = \frac{3+\sqrt{5}}{4} A = 1{\cdot}309017\,A$, and by similar triangles $AD : DC :: CA : \frac{AC \times CD}{DA} = \frac{5+3\sqrt{5}}{20} A = {\cdot}5854102\,A$ = the radius of the inscribed hemisphere; and consequently its solidity is $\overline{{\cdot}5854102A}|^3 \times \frac{2}{3} \times 3{\cdot}14159$ &c. $= {\cdot}4201837\,A^3$.

Also, a square may be inscribed in a pentagon by placing one of its sides parallel to a side of the pentagon; and, by calculation, it appears that, if z be the side of the square, $z \div 1{\cdot}0604974$ will be the side of the pentagon; hence, if this square be one face of the cube, and the pentagon the section of the pentagonal pyramid parallel to the base and distant from it the height of the cube, we shall have, by similar figures, $AC : BE :: AC - z : z \div 1{\cdot}0604974$; hence $z = \frac{1{\cdot}0604974\,AC}{1{\cdot}0604974\,A + AC} \times A = {\cdot}5431802\,A$ = the side of the cube: And consequently the cube of this, or ${\cdot}1602626\,A^3$ = the content of it.

Collecting now these three sums together, and multiplying by 2, we have $4{\cdot}2516646\,A^3$ for the contents of the twelve cavities.

But, by p. 408 Mensuration, $5A^3 \sqrt{\frac{47+21\sqrt{5}}{40}} = 7{\cdot}6631189\,A^3$ = the content of the dodecaedron.

Consequently the difference of these two $= 3{\cdot}4114543\,A^3 = 1746{\cdot}6646016$ inches $= 1{\cdot}0108013$ feet = solidity remaining; which at 60 *lb.* a foot, weighs $60{\cdot}648077$ *lb.*

N. B. *False numbers (but no methods of solution) are given to this question in* The Diarian Repository.

A false solution is also given to question 25 in that book, dissimilar solids being used as similiar ones.

Other mistakes are remarked on the covers of this number.

beginning is 45 min. 42 ſec. and at the end 39 min. 12 ſec. north deſcending, the lower or ſouth limb of the moon being darkened. The fourth eclipſe is of the ſun, on the 6th of december, 4 ho. 22 m. p. m. but inviſible to us, the ſun being below the weſtern horizon.*

New Queſtions.

I. *Queſtion* 29, *propoſed by Mrs.* Sarah Brown.

I aſk'd my love when ſhe would wed?
She cry'd ſhe was too young;
And that ſhe would ſtill ſome years ſtay:
I aſked her, how long?
Until my years being multiply'd
By't ſelf, and when you find
('Bating one-ninth, adding one-third)
Nine hundred lacking nine:
I pray you, ladies, help me find
What age ſhe'll be when we are joyn'd.

II. *Queſ-*

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* *The* 3d *Eclipſe or that for November* 21.

This eclipſe was obſerved as follows:

I. At *Rome* by Mr. *F. Blanchin.*

Time afternoon h.	m.	s.	
12	53	34	A ſtar in Taurus, by Bayer marked τ, nearly applied itſelf to the moon's limb; obſerved by a teleſcope of 12 palms.
12	54	34	It was now hid by that part of the moon's limb, which is almoſt in the middle between the ſpots of Ariſtarchus and Galileus.
14	0	14	Sirius came to the meridian, by which the times were verified.
15	0	0	The penumbra in the limb of the moon, which before was pretty dilute, is now become ſenſibly denſer.
15	4	20	The beginning of the incidence of the moon into the true ſhadow, on that part of the limb which is next to the ſpot Schickard.
17	27	45	The true ſhadow comes out of the limb of the moon, in a place marked out by drawing a diameter between Ariſtarchus and Plato.

II. At the town of *S. Joſeph*, which is 3 h. 52 m. 30 s. difference of meridian from R. Obſ. Par. By *F. Bon. Suerez.*

10	33	31	Beginning
12	56	57	End

The greateſt quantity obſcured was dig. 5 at about 11 h. 45 m.

II. *Question* 30, *by* A. W.

At London one morning the ſun ſhining plain,
The ſhadow I found the juſt length of my cane,
As I held it upright; 'twas the tenth day of May:
Now tell me exactly the time of the day?

III. *Queſtion* 31, by *Mr.* Rob. Wilſon.

A caſtle wall there was, whoſe height was found
To be an hundred feet from top to th' ground:
Againſt the wall a ladder ſtood upright,
Of the ſame length the caſtle was in height.
A waggiſh fellow did the ladder ſlide
(The bottom of it) ten feet from the ſide.
Now I would know how far the top did fall,
By pulling out the ladder from the wall.

IV. *Queſtion* 32, *by Mr.* Lover.

Three farmers did meet, as they rode on their way,
The firſt to the other two farmers did ſay,
If you give me two-thirds of each of your coin,
Then eighty ſix nobles will be equal to mine.
Nay, friend, ſays the ſecond, if I ſhould receive
Three-fifths of both yours, the ſame ſum I ſhall have:
But if from the two firſt, five-eighths the third take,
Then his the ſame eighty ſix nobles will make:
Inform me what each of them had at the firſt,
Likewiſe in exchanging what each man diſburſt.

V. *Queſtion* 33, *by Mr.* Peter Walter.

A noble lady of as noble parts,
Whoſe wit and beauty crown'd her queen of hearts:
Her noble works the learned world amaz'd,
As did the caſtles in the air ſhe rais'd.
In one of theſe a certain night ſhe laid,
Nor did the caſtle's height make her afraid,
Tho' in the air ſev'n meaſur'd miles 'twas rais'd.
On the next morn betimes ſhe did conſpire
By art to raiſe her ſeat a ſtory higher:
A fancy then had juſt receiv'd its birth,
When fell her ſtandiſh down from thence to earth;
At the ſame inſtant, ſhe a ſound did hear,
Which came from earth, and pierc'd her tender ear:
Well done, (ſaid ſhe) I'll of my ſelf demand,
(For why my fancy ne'er was at a ſtand)
How long my ſtandiſh was in falling thither;
How long the ſound was mounting till 't came hither.

Come

Come artists inform me how it is to be done;
There are many can tell me, but ask a round sum:
But knowing there generous persons may be,
Who will do it for nothing, such will oblige me.

VI. *Question* 34, *by Mr.* Josiah Clayton.

Sixty thousand brave soldiers in battalia there were,
Plac'd in a vast plain, and in form a long square:
Now on how many acres of ground did they stand,
At two yards, three quarters, between man and man?
And how many in rank and in file will there be,
When their length to their breadth is as two is to three?

The Prize Question, by Mrs. Anna Wright.

Within the glorious firmament serene,
Amongst the constellations there is seen
The little bear, whose tail's end now doth rowl
The nearest to the frozen northern pole.
But what star 'twas, is what I now require,
O'th' second magnitude that did appear
To be to the north pole the next of all,
When first God framed this terraqueous ball?
Since which are years (as best accounts relate)
Fifty seven hundred and sixteen complete:
Its distance from the pole, that time pray shew,
And, when requir'd, I'll do as much for you.

1714.

Solutions to the last year's questions.

* I. *Question* 29, *answered by Mr.* Lingen *from* Ireland.

UNhappy man! behold how long you are condemn'd to stay,
Before your love, your pains to ease, has fix'd the joyful day;
Till seven and twenty years she'as past, relief ne'er hope to find,
If near that age she has arriv'd, then ease your tortur'd mind.

By

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* I. QUESTION 29. *solved.*

Since $\frac{1}{9}$ taken from 1 leaves $\frac{8}{9}$, and this increased by $\frac{1}{3}$ or $\frac{3}{9}$ becomes $\frac{11}{9}$; hence the question is to find a number whose square multiplied by $\frac{11}{9}$ may produce 891.

Consequently, 11 : 9 :: 891 : the square of the number,

Or, $\sqrt{11} : \sqrt{9} :: \sqrt{891} : \sqrt{\frac{891 \times 9}{11}} = \sqrt{81 \times 9} =$ 27 = the number sought.

I 3

By Mr. Joſhua Lover *of* Chicheſter.

S ince 'tis a fair one this requeſt doth crave,
A loving huſband ſhe alſo ſhall have:
R ichly adorn'd with nature's comelineſs,
A nd let true vertue in each heart poſſeſs,
H appy are they thus providence doth bleſs.
B ut ſince 'tis age this fair one doth require,
R eady I am to grant her nice deſire:
O f what number, when ſquar'd nicely and true,
W hen one ninth, one third being put thereto.
N ow twenty ſev'n doth a right anſwer ſhew.

Anſwered by Mr. Dan. Hatton *of Tewkeſbury.*

To a true lover, I diſcover,
The charming maiden's years;
Which ſhe may find, to eaſe her mind,
Juſt twenty ſeven years.

* II. *Queſtion* 30, *anſwered by Mrs.* Adway.

London, laſt may the tenth, in morning time,
I trow, I calculate, or well project,
The ſun's height forty five, the hour was nine,
Minutes thirteen, ſeconds twice ten exact.

† III. *Queſtion* 31, *anſwered by Mr.* John Boſwell.

Six inches, half a quarter, the top did fall,
By pulling the ladder ten foot from the wall.

And by Mr. T. Buſey *of St. Nicholas in Kent.*

The ladder's deſcent muſt certainly be,
From th' top of the wall, as here under you ſee.
·50126 feet = 6 inches ·01512.

IV. *Queſ-*

* II. QUESTION 30. *ſolved.*

Suppoſing the ſun's declination may 10th, 1712, to be 20° 16′ 32″; we ſhall have given the three ſides of a ſpherical triangle, to find an angle: viz. the complement of the declination = 69° 43′ 28″, the complement of the latitude = 38° 28′, and the complement of the altitude = 45°, to find the hour angle, or angle between the two former; and which by calculation comes out 41° 41′ 4″ = in time to 2 h. 46 m. 44 s. which being taken from 12 h. we have 9 h. 13 m. 16 s. for the time required.

† III. QUESTION 31. *ſolved.*

By right-angled triangles, $\sqrt{100^2 - 10^2} = 30\sqrt{11} =$ 99·4987437, which taken from 100, there remains ·5012563 feet = 6·0150756 inches = the number required.

* IV. *Queſtion* 32, *anſwered by Mr.* Edens.

Your knotty queſtions of the farmers, I
By algebraick art do here untye,
All which you aſk, exactly I diſcover,
Becauſe o'th' art, I find you are a lover.

The 1ſt had	$30\frac{8}{37}$ nobles	$=$ 10*l.*	1*s.*	$5\frac{1}{4}$*d.*		187.
2d —	$44\frac{6}{37}$ —	$=$ 14	14	$4\frac{3}{4}$		888.
3d —	$39\frac{19}{37}$ —	$=$ 13	3	5		329.

† V. *Queſtion* 33, *anſwered by Mr.* John Newbold.

Thoſe pyramids ſo often fam'd in ſtory,
For the world's wonder, and for Egypt's glory.
And Babylon ſo much by the antients prais'd,
Muſt loſe their fame, now your vaſt fabrick's rais'd.
The Alps, and Pico, ſeem their tops to droop,
And art bids nature's ſtately pride to ſtoop.

The

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* IV. QUESTION 32. *ſolved.*

Putting $a = 86$ nobles, and z, y, x for the 1ſt, 2d, and 3d perſon's nobles reſpectively; we ſhall have, by the queſtion,

$$z + \tfrac{2}{3}y + \tfrac{2}{3}x = a, \quad \text{Or } 3z + 2y + 2x = 3a,$$
$$y + \tfrac{3}{5}z + \tfrac{3}{5}x = a, \quad \text{Or } 3z + 5y + 3x = 5a,$$
$$x + \tfrac{5}{8}z + \tfrac{5}{8}y = a, \quad \text{Or } 5z + 5y + 8x = 8a.$$

Taking the 1ſt equation from the 2d, we have $3y + x = 2a$, or $x = 2a - 3y$; this ſubſtituted in the 1ſt and 3d, we have $\left.\begin{array}{r}4y - 3z = a\\ 19y - 5z = 8a\end{array}\right\}$; from 3 times the latter of theſe equations ſubtract 5 times the former, and there will be obtained $37y = 19a$; hence $y = \frac{19a}{37} = 44\frac{6}{37}$ nobles $= 14l.\ 14s.\ 4d.\ 3\frac{33}{37}q.$ Then $x = 2a - 3y = \frac{17a}{37} = 39\frac{19}{37}$ nobles $= 13l.\ 3s.\ 5\frac{3}{37}d.$ And $z = \frac{4y - a}{3} = \frac{13a}{37} = 30\frac{8}{37}$ nobles $= 10l.\ 1s.\ 5d.\ 1\frac{7}{37}q.$

† V. QUESTION 33. *ſolved.*

Since ſound flies 1142 feet in a ſecond of time, we ſhall have 7 miles $\div$ 1142 feet $= 36960$ feet $\div 1142 = 32\frac{208}{571} = 32{\cdot}36427$ ſeconds $=$ the time of the aſcent of the ſound.

Again, Since the times of deſcent are as the roots of the ſpaces, and $16\frac{1}{12}$ feet is the ſpace fallen in the 1ſt ſecond, wherefore $\sqrt{16\frac{1}{12}} : \sqrt{36960} ::$ 1 ſecond : $\sqrt{\frac{36960}{16\frac{1}{12}}} = 47{\cdot}93778$ ſeconds $=$ the time of the body's deſcent.

The vaſt ſicilian hill, whoſe jaws expire
Thick clouds of duſt, and vomit flames of fire,
Strikes not ſuch wonders in beholders eyes,
Or ſtupifies th' amazed faculties;
The architecture in their works does ſhine,
As from the product of a power divine.
To name the height would be but labour loſt,
Yet 'fear your expectation ſhould be croſt,
The numbers underneath, if manag'd right,
Will ſolve th' demand, and give the tow'ring height.
The time it was falling was 48 ſeconds.

Anſwered by Mrs. Mary Nelſon.

That lady ſo fair, (with her ſtandiſh) i'th' air,
Let fall from a place ſo ſublime,
Ere it came to the ground, or made any ſound,
'Twas near forty eight ſeconds of time.
But before that her ear the ſound could well hear,
So ſlowly it made its retreat,
Great Newton ſo clear has made it appear
'Twas forty eight ſeconds compleat.

I received nine ſeveral anſwers to this queſtion, with ſome ſmall difference, in regard they calculated the acceleration of deſcent, and motion of ſounds, from different data. Of which numbers were *Pylander*, Mr. *Parker*, *Richards*, *Wilſon*, and Mrs. *Sidway*; who ſuppoſing the univerſal meaſure to vibrate well at the caſtle, after anſwering the queſtion, has propoſed this following:

Now in return, good ſir, be pleas'd to try
To find the caſtle's height, when rais'd ſo high,
That in what time the ſtandiſh fell down hither,
So long the ſound was mounting till 't came thither.
When the weight touch'd the ground, tell what degree
It had acquired of velocity. VI. *Queſ-*

Mrs. SIDWAY'S *Queſtion ſolved.*

Putting $a = 16\frac{1}{12}$, $b = 1142$, and $x =$ the height of the caſtle in feet. Then, as in the laſt ſolution, $\frac{x}{b}$ will expreſs the time of the ſound's aſcent, and $\sqrt{\frac{x}{a}} =$ the time of the body's deſcent; hence $\frac{x}{b} = \sqrt{\frac{x}{a}}$, and $x = \frac{bb}{a} = 81087\frac{177}{193}$ feet $=$ 15 miles $1887\frac{177}{193}$ feet $=$ the height of the caſtle.

And ſince the velocity is as the root of the ſpace deſcended, and $2a$ the velocity acquired by falling through a, we ſhall have $\sqrt{a} : \sqrt{x} :: 2a : 2\sqrt{ax} = 2\sqrt{bb} = 2b =$ double the velocity of ſound, or 2284 feet *per* ſecond.

* VI. *Quest.* 34, *answered by* J. Lewes *of Landkey, Cornwall.*

If sixty thousand soldiers placed so be,
In rank and file, as two is to three;
Place 300 in rank, and 200 in file,
And the question to answer you will not fail.
And on how many acres of ground they do stand,
At eight foot three inches between each man;
I answer, 'tis 92 acres of land. (and 155 Perch.)

By Mr. Jos. Boydall.

Your sesquialteral oblong squadron must stand
On ninety two acres, and three fourths of land:
And if they do your well-form'd order keep,
The rank's three hundred, and two hundred deep.

I received near 20 answers to this last question: one half of them say, 'tis 93 acres and three quarters. The others, and the proposer say, 92 acres and three quarters, and 35 perches. The former, I suppose, forgot to make the number of distances less by one than the persons. And tho' I received abundance of curious answers to each question, yet I am obliged to omit them, and shall conclude the answers with one sent from Birmingham, that concisely answers all the questions.

Till she's full 27, your preud will not wed:
But sooner by ten years I hope to be sped. Q. 29
The time of the morning (if art we may trust)
Was 9, 13 minutes, 40 seconds just. 30
If the bottom do slide 10 feet from the wall,
The ladder's top down 6 inches will fall. 31
In answer to th' next, you'd think me distracted, 32
Shou'd I put into rhime these † numbers so fracted.
If a body descends 16 foot (as 'tis reckon'd) 33
And sound moves 1000 feet just, in one second;
Then in 48 seconds the dish came to ground,
And 37 more return'd back the sound.
200 and 300 of the square are the latera, 34
And 92 acres cover'd with a small ‡ *&c.*
I write short, but talk less, and out I go little;
If you like such a wife, I'm yours, Dor. Dolittle.

† $30\frac{8}{17}$. $44\frac{6}{17}$. $39\frac{10}{17}$. ‡ 92 *acres* 3 *roods.*

In this method Mr *Will. Beriff* answered all the questions except the first. *Answer*

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* VI. QUESTION 34. *solved.*

As the sides must be in proportion to each other as 2 to 3, and their product 60000, it is evident that they must be 200 and 300. Then the ground upon which they stand will be $= 299 \times 2\frac{3}{4} \times 199 \times 2\frac{3}{4} = \frac{7199621}{16}$ yards $= 92$ acres, 3 roods, $35\frac{1}{4}$ perches.

* *Anſwer to the Prize Queſtion.*

To the prize queſtion propoſed laſt year, I received abundance of letters, in anſwer, (before Candlemas-day, on which the lots were drawn) out of which there were but four true anſwers, *viz.* by Mrs. *Barb. Sidway*, Mr. *Rich. Parker*, Mr. *John Edens*, and *H. B.* And that ſo many were miſtaken in their anſwers, there are two reaſons. Firſt, In Sir Jonas Moor's and ſome other catalogues, that ſtar (call'd by Kepler in his Rudolphine Tables Tertia ab Extrema in Cauda Draconis) is accounted of the 3d magnitude, and thoſe who had recourſe to theſe tables, took the middle ſtar in the great bear, or the guard-ſtar in the little bear's ſhoulder, to anſwer the queſtion. But thoſe who took Tyco's catalogue, or Seller's northern conſtellations, where that ſtar is of the 2d magnitude, truly anſwered the queſtion. A ſecond reaſon was, (tho' the difference is inconſiderable) ſome aſtronomers ſay the preſceſion of the equinox is 48, and others 50 ſeconds in a year.

At drawing the lots it fell to Mr. *John Edens*, who had ten diaries preſented to him, and anſwered thus:

When th' great Jehovah fram'd the ſkies,
He made the earth and ſtars likewiſe,
And plac'd them all, as pleas'd him beſt,
All rowling from the eaſt to th' weſt.
Beſides that motion, he decreed,
Contrarily they ſhould proceed;
And make their revolution,
Round to the place they firſt begun:
Which in ſet times theſe ſubjects they
Their mighty monarch's will obey.
If the account is right, as you relate,
Since God did firſt this earth create,
I'th' dragon's tail you may behold
The ſtar which next the north pole rol'd;
And if you view the ſcheme below,
Its diſtance from the ſame you'll know.

		°	′	″
The longitude of the firſt in ♈ 1712 - - - -		29	11	14
The ſtar in Draco from ♈ - - - - - - - - - -	ad.	124	33	30
Longitude of that ſtar, 1712 - - - - - - - - -		153	44	44
Moved in 5716 years - - - - - - - - - - - - -	ſub.	80	52	53
Remains the long. at the creation - - - - - - - -		72	51	51

Lat. according to Tyco, 66° 36′ north. Then

As the cotan. 23° 30′ : is to the radius ::

So is the ſine of 72° 51′ : to the tang. 22° 33′, which ſubtract from the compl. of the ſtar's lat. leaves 50′ 12″. Then

As

As the cofine	22° 33″	To the cofine	50′ 12″
So is the cofine	23 30	To the cofine	6° 48

Six degrees forty eight minutes the diftance of that ftar from the pole at the creation.

Mrs. Sidway's *anfwer.*

That ftar o'th' fecond brightnefs that did roll
At the creation, next the northern pole,
Some call the dragon's tail; but others fay,
'Tis call'd of tail the antepenultima.
Its diftance then fix degrees and one half,
It has been much nearer, now further off.
When father Noah threefcore was, and odd,
More than five hundred years before the flood,
Scarce ten minutes from the pole it ftood.*

Of

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* PRIZE QUESTION *anfwered.*

The annual preceffion of the ftars being 50·336 feconds of a degree, the preceffion from the creation to the year 1760 will be = $\overline{5716+48} \times 50{\cdot}336 = 5764 \times 50{\cdot}336 = 290136$ feconds = 80° 35′ 36″. To this preceffion add 3 figns or 90°, the longitude of the north pole of the equator, and we fhall have 5 s. 20° 35′ 36″ for the prefent longitude of the ftar required; and the ftar of the fecond magnitude, whofe longitude is neareft to that, and latitude 66 nearly, was the pole ftar required; which appears to be the third ftar in Draco, reckoned from the tip of the tail, which is the ftar marked, by Bayer, α.

Now to find the diftance of this ftar from the pole at the creation. By the catalogue of ftars at the end of the Nautical Almanac for the year 1773, the latitude of α Draconis is 66° 21′ 15½″, (its complement 23° 38′ 44½″), and its longitude in the year 1760 was 154° 2′ 46″; from this fubtract (80° 35′ 36″) the preceffion fince the creation, and we have 73° 27′ 10″ for the longitude of this ftar at the creation, whofe complement is 16° 32′ 50″: Alfo, fince the diminution of the inclination of the earth's axis is 47″ in 100 years, in 5764 years its change will be 45′ 9″, which being added to 23° 28′ 17″ the inclination in the year 1760, we fhall have 24° 13′ 26″ for the angle made by the axes of the ecliptic and equator at the creation. Hence in an oblique fpherical triangle, we have given two fides and the included angle, to find the third fide; *viz.* given one fide = 24° 13′ 26″ the diftance of the pole of the equator from that of the ecliptic, the other fide = 23° 38′ 44½″ the diftance of the ftar from the pole of the ecliptic, and the included ∠ = 16° 32′ 50″ the complement of the ftar's longitude: Then, by trigonometry, is found the 3d fide = 6° 43′ 10″ the required diftance of the ftar from the pole of the equator at the creation.

Of the Eclipſes.

An eclipſe of the ſun is cauſed by the interpoſition of the moon's dark body between the moon and our ſight, for the moon being then under the ſun, doth come in a direct line between the ſun and our eyes, and ſo by the thickneſs and opakeneſs of her body doth obumbrate and hinder the ſun from ſhining upon us; and this always happens at the conjunction of the ſun and moon, or new moon, but not at every new moon; but only when the conjunction falleth in or near to either of the nodes, at which time ſhe hath little or no latitude from the ecliptick.

An eclipſe of the moon is cauſed by the direct interpoſition of the earth between the ſun and her; then theſe three great bodies are all in one diametrical and ſtraight line, the dark body of the earth being between the ſun and moon, doth hinder the beams from ſhining on the moon, and ſo the moon having no light of her own, but what ſhe receiveth from the ſun by reflection, doth really become dark: and theſe eclipſes always happen at full moon, but not at every full moon, but at ſuch when ſhe is in or near the ecliptick. And although

There will happen four eclipſes this year 1714, yet not one of them will be viſible in England.

The firſt eclipſe is of the moon, on the 18th day of may, half an hour after 7 in the morning, but not viſible to us, the moon being then ſet, but may be ſeen in Newfoundland in America.

The ſecond is of the ſun, the 1ſt day of june, inviſible.

The third is of the ſun, the 27th of october, at 5 in the evening, the ſun being then ſet, therefore inviſible to us.

The fourth eclipſe is of the moon, the 10th day of november about noon, inviſible.

Theſe eclipſes this year being ſo inconſiderable, I will give you an account of as great an eclipſe as has happen'd in England theſe 50 years. It is of the ſun, the 22d day of april, 1715, beginning 6 minutes after 8 in the morning, and laſts above two hours: the ſun will be ſo totally obſcured for the ſpace of 2 minutes and a half, that the ſtars will appear as though it was night. A full account of this eclipſe you ſhall have in my next.

New

New Arithmetical Queſtions.

I. *Queſtion* 35, *propos'd by* Mr. John Wilſon.

Aſſiſt you ladies, that in art are ſkill'd,
And have the bitter ſweets of love once feel'd;
You I invoke, and on your aid rely,
To help me in my great'ſt extremity.
Oh! how the ſcene is chang'd, as in a trice,
I who could others counſel, want advice.
My ſweet Eliza was ſo charming fair,
That Dian's nymphs might none with her compare:
Nor was her face ſo charming as her mind,
Her chaſte love free, and to her ſwain was kind.
But above all, her intellectual part
Was virtuous, witty; conſtant was her heart.
This render'd me, when in Eliza's arms
I lay, incircl'd 'midſt a thouſand charms,
The happy'ſt mortal breathing on the earth:
But now my torment's far more worſe than death,
Till you, fair ladies, your aſſiſtance lend,
And give an anſwer to the lines I ſend.
Eliza's father, cruel both to me
And to my dear Eliza, furiouſly
Snatch'd my deareſt from m'encircling arms,
And utterly denies our future charms,
Till I ſhall count the portion of my dear,
And what he's worth in all, to him declare.
'Three ſevenths of 's eſtate my dear's to have:
'The other four to his own uſe he'll ſave.
'Now what's eſtate is worth I fain would know;
'But he no more than this will to me ſhow:
'The pounds being cub'd, the product of that ſum
'Will to a number of nine figures come:
'Which by the ſquares of eight and three divide,
'And in the quotient ſtill there will abide
'Thouſands three hundred fifty two, and more,
'Nine hundred forty ſeven: On which I pore
Both day and night; but I no good can do:
Therefore my whole dependence lies on you.

II. *Queſtion* 36, *by Mrs.* Barbara Sidway.

A gardiner he had an upright cone,
Out of which ſhould be cut him a rolling ſtone,
The biggeſt that e'er it could make.
The maſon he ſaid, that there was a rule
For ſuch ſort of work, but he had a thick ſkull.
Now help him for pity's ſake.

III. *Quest.* 37, *by Mr.* John Hodge, *of Truro, in Cornwall.*

Two esquires of late, of noble estate,
Once happ'ned to fall at discord;
Their wrath grew so high, nothing could pacifie,
But the law or the point of the sword.
Their counsellors were a jolly brisk pair,
And having good clients in hand,
Resolved to use them as friends (not abuse them)
As by this you may understand.
In tavern being met, they concluded it fit
This matter in law to delay,
So long as they nine could change places to dine,
And make but a change ev'ry day.
How long must they sit, tell I pray?

IV. *Quest.* 38, *by Mr.* Crabb *of Whitlackington in Somerset.*

A gentleman with his artif'cer did
Agree for building a round pyramid;
And for each foot solid the same did contain,
Seven pence was the price; no more, loss or gain:
And now, I must tell ye, it was his good pleasure
To have it be made, just after this measure;
That when it was rais'd, in inches six score,
Twelve hundred and fifty foot solid be more
Built thereon: and let the height in this case,
From the top o'th' same, to the center o'th' base
Be in proportion to the circuit there,
As five is to four: and now observe here,
'Twas also agreed, that for the same pay,
To have a room in't, made square ev'ry way,
As large as the cone would admit of, I say.
But I am in doubt, he can't do't alone:
Pray help him therefore in building this cone.
And th' girt at the base, with th' height to him give,
With the side of th' room, and what he must have
For building this cone, is all I do crave.

V. *Quest.* 39, *by Mr.* Richards, *of St. Thomas's, nigh Exon.*

The first king of Assyria, Ninus by name,
Took to wife Semiramis, that valorous dame,
Who repair'd old Babylon, when 'twas decay'd;
And by her great courage made her foes afraid.
But one thing to her fame I think proper to quote,
Which is of all others the most proper to note:
'Tis that obelisk of marble she caus'd to be fet
From the armenian rocks, and in Babylon set.

It

It was pyramid like; the baſe twenty foot ſquare,
'Twas of one ſolid ſtone, and (as authors declare,
If meaſur'd) one hundred beſides fifty foot high:
This carriage was prodigious, you'll quickly reply.
Now (pardon the wildneſs of my fancy) ſuppoſe
Being ſunk in Euphrates, it were thence to be roſe,
What weight were ſufficient this ſtone to raiſe up,
Till the point of the ſame ſhould appear at the top,
Or ſurface o' th' water? beſides how much weight more
Muſt be added to bring it as it was before
It was ſuch? I mean, the whole ſtone above water;
For when we have done this, we have finiſh'd the matter:
For I hope they'll take care and not ſink it again,
If Euphrates ſalt water its weight will ſuſtain.

VI. *Queſtion* 40, *by Mr.* John Newbold.

In walking the ſtreet, I met with a briſk blade,
An honeſt old lad, and a cooper by trade:
He was merry in mind, but his whiſtle was dry;
You'd have laugh'd your guts out in hearing him cry
Any buckets or tubs, any barrels to mend;
Here's hoops of all ſizes: pray make uſe of a friend.
I obſerv'd him a man of abundance of tattle,
And that moſt of his knowledge conſiſted in prattle;
Then reſolv'd with myſelf that I'd give him a rub;
So I aſk'd him to make me a conical tub;
Its baſe thirty inches, and a hoop there ſo wide
Should, if placed upright, the whole tub circumſcribe;
And with the four ends of the diameters right,
And hold in ale gallons, nineteen ninety eight. (19·98)
To work he ſtreight went; but ſoon found that his ſkill
Was too ſhallow the problem propos'd to fulfill:
So deſires in this letter the favour from you,
To ſend the requeſt underneath very true:
The depth of the tub, and diameter leaſt,
And hopes that the ladies will grant the requeſt:
And as a reward (now his brains are grown dunch)
He'll treat them next year with a tub full of punch.

The PRIZE QUESTION, *of* 10 *Diaries, to be determined by Lot among thoſe who anſwer it before Candlemas.*

[As this Queſtion is propoſed in very bad verſe, I ſhall here turn it into plain proſe.]

In gauging a ſpheroidical ale caſk, I found the diameter of one head to meaſure 18·1 inches, that of the other 16, the bung diameter 20, and the diſtance between the two heads 20·6 inches; alſo, by the caſk lying a little obliquely, I obſerved that

that the liquor juſt roſe to, or touched, the upper extremities of the two heads. Having noted theſe dimenſions, I was informed that there were in the caſk a ball of iron weighing 60*lb.* another ball of lead weighing 90*lb.* and a cube of box, a foot ſquare. Pray what quantity of liquor was in the caſk.

1715.

Solutions to the laſt year's Queſtions.

* I. *Queſtion* 35, *anſwered by Mr.* Peter Walter, *and Mr.* Ja. Cole, *of Portſmouth.*

GOOD ſir rejoyce, now you your point ſhall gain,
And in your arms your charming fair detain;
Then to her father with aſſurance go,
Tell him you do his daughter's portion know,
For 'tis the number which you find below.
The father's eſtate, 588 *l.* The daughter's portion, 252 *l.*

The ſame anſwered by Mr. William Vorley, *writing maſter at Holbech, Lincolnſhire.*

You may marry Eliza as ſoon as you will,
For I've found out her father's eſtate by my ſkill
In arithmetick, if that I be right,
To be pounds five hundred eighty and eight;
Yet to be more kind, unto you I'll ſhew,
That pounds two hundred fifty and two,
Is her juſt portion. I joy her to you.

This queſtion was anſwered by Mr. *Moyle*, Mr. *Hatton*, Mr. *Shepheard*, Mr. *Crabb*, Mr. *Lingen*, Mr. *Cooch*, Mr. *Beriff*, Mrs. *Jone Jolly*, Mr. *Hall*, Mr. *Elphick*, *Gynœphilus*, Mr. *Hayward*, Mr. *Carter*, Mr. *Ragg*, Mr. *Widdows*, Mr. *Woodham*, Mr. *William Bainham*, Mr. *Edens*, Mrs. *Nelſon*, Mr. *Williams*, and others.

II. *Queſ-*

* I. QUESTION 35. *ſolved.*

Since the cube of the number of pounds in the whole eſtate is equal to $352947 \times 64 \times 9 = 203297472$, the number itſelf muſt be equal to the cube root of this number, which is 588 *l.* = the whole eſtate. Conſequently $\frac{3}{7}$ of 588 = 252 *l.* is the lady's portion

* II. *Queſtion* 36, *anſwered by Mr.* Newbold.

Honeſt maſon, thro' Mrs. Sidway's perſwaſion,
  I'll ſhew you the way for to cut
The greateſt cylinder out, of all cones without doubt,
  And this is the way you muſt do't:
Through the middle of its height, cut the cone right
  To its axis, and then you will find,
A cylinder in this caſe, muſt have ſuch a baſe,
  For the greateſt to be of its kind.

Mr. *Beriff*, Mr. *Hall*, Mr. *Wylde*, and Mr. *Clayton*, ſay it muſt be cut thro' $\frac{1}{3}$ of its height, agreeing to the propoſer. Mr. *Williams*, Mr. *Andrews*, Mr. *Crabb*, and Mr. *Cole* anſwered this queſtion.

† III. *Queſtion* 37, *anſwered by Mr.* Tho. Dodd.

May ſuch amuſements always end raſh ſtrife,
Deſtructive of the peaceful ſweets of life:
Had they but ſat each day in diff'rent range,
And liv'd to ſee how often they could change,
They'd ſeen more days than all *Methuſalah*'s
Juſt twenty four, with ſix and nine ſcore days.

And by Mr. Lingen, *and Mr.* Nath. Kew, *of Bath.*

How few can we find, ſo good of that kind,
  So generous, ſo wonderful civil;
I have felt the curſt claws of ſome traders in laws:
  Deliver us Lord from that evil.

They muſt have continued 993 years, and 186 days.

IV. *Queſ-*

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* II. QUESTION 36. *ſolved.*

From ſeveral ſolutions that have been given of this queſtion, it is very certain that the cone muſt be cut at *one-third* of its altitude.

† III. QUESTION 37. *ſolved.*

The time required will be $= 1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 \times 9 =$ 362880 days; which, at $365\frac{1}{4}$ days to the year, come to $993\frac{249}{487}$ years.

* IV. *Question* 38, *answered by Mr.* John Newbold, *Mr.* Lewis Evan, *Mr.* Abel Ragg, *Mr.* John Andrew, *Mr.* Nich. Stevens, *and Mrs.* Nelson.

What human pleasures more delight the mind,
Or solid notions satisfaction find,
Than centred are in mathematick skill;
The sweet endowment of that splendid quill.
—— The question 38 is so sublime,
It makes the nine harmonious numbers chime
Into a theorem of a high degree,
Sursolid much adfected it will be;
Which I determine by converging series,
And underneath have solved all its queries.

	feet	inch.
The circumference of the pyramid at the base	41	6
The whole height of the cone - - - - - - - -	51	10
The side of the room - - - - - - - - - - - -	7	11

The content in solid feet when the room is deducted, 1878·1093. The charge of the building, 54 *l.* 15 *s.* 6 *d.*

V. *Ques-*

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* IV. QUESTION 38. *solved.*

Put $a = \cdot 785398$ &c. and $5x$ and $4x$ for the altitude and circumference of the upper part whose content is 1250. Then its solidity is $\frac{5x^3}{3a} = 1250$; hence $x = \sqrt[3]{750a} = 8\cdot 382697$. Consequently the altitude of the whole cone $= 5x + 10 = 51\cdot 913485$ feet $= 51$ feet $10\cdot 96182$ inches, and the circumference of its base $= 4x + 8 = 41\cdot 53078$ feet $= 41$ feet $6\cdot 369456$ inches: Also, by similar solids, $5x^3 : \overline{5x+10}|^3 :: \left(\frac{5x^3}{3a} =\right) 1250 : \overline{\frac{x+2}{x}}|^3 \times 1250 = 2375\cdot 14 =$ solidity of the whole cone.

Now, if $A = 5x + 10 = 51\cdot 913485$ the altitude of the whole cone, and $z =$ the side of the inscribed cubical room; by similar figures we shall have $A : \frac{A}{10a} :: A - z : \frac{1}{2}z\sqrt{2}$; hence $z = \frac{A}{1 + 5a\sqrt{2}} = 7\cdot 921364$ feet $= 7$ feet $11\cdot 056368$ inches $=$ the side of the room; the cube of which gives $497\cdot 05$ for the vacuity.

Taking this from the whole solidity $(2375\cdot 14)$ we obtain $1878\cdot 09$ for the solid part; which, at 7 *d.* a foot, produces 54 *l.* 15 *s.* 6 *d.* 2·52 *q.*

* V. *Queſtion* 39, *anſwered by Mr.* Newbold.

When noble thoughts inveſt a noble ſoul,
And martial ardours all the mind controul;
When female ſpirits dare encounter thoſe
Sad dangers we to fancy ſcarce ſuppoſe;
Darting their courage through their ſplendid eyes,
And maſter danger with the leaſt ſurprize:
Oh! Semiramis, what ſtrange acts I find
Recorded of thy elevated mind,
Eſpecially the ſtately pile thou'ſt ſet
In *Babylon*, has made thy works complete,
And ſet the poets wits at ſtrife to feign
Sufficient words t' immortalize thy name.
Some fain would know how much 'twill weigh
when in the air, and in the ſea.
And for to pleaſe the minds of thoſe
Their whole requeſts I here diſcloſe.

	Tun.	*cwt.*	*qr.*	*lb.*
To raiſe it to the ſurface — — —	939	3	2	10
To be added to raiſe it out — —	573	12	3	25
The weight in the air — — —	1512	16	2	7

This calculus is according to Mr. *Ward's* tables of ſpecifick gravities, and differs conſiderable from thoſe taken from Philoſophical Tranſactions.

To this queſtion I received true anſwers from Mr. *Peter Ward*, Mr. *Tho. Fearne*, Mr. *Crabb*, Mr. *Beriff*, Mr. *Hall*, Mr. *Edward Elphick*, Mr. *Abel Ragg*, Mrs. *Mary Nelſon*, and Mrs. *Carrington*.

To the 40th queſtion I received but one anſwer, from Mr. *Edens*; although I conceive the queſtion very well explains the meaning, yet I find moſt perſons were at a loſs in anſwering it. 'Tis no more but to find a fruſtrum of a cone that

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* V. QUESTION 39. *ſolved.*

The ſolidity of the pyramid will be $20^2 \times \frac{150}{3} = 20000$ feet $=$ 34560000 cubic inches. Now by *Ward*'s table of ſpecific gravities, a cubic inch of marble weighs 1·568859 ounces avoirdupois, and an inch of ſalt water ·594894 ounces; and their difference is ·973965. Whence, the weight required to raiſe the point of it to the ſurface of the water will be $\cdot973965 \times 34560000 = 33660230\cdot4$ *oz.* $=$ 939 *tons* 3 *cwt.* 2 *qr.* 12 *lb.* 6·4 *oz.*

And it is evident that the whole weight of the marble will be neceſſary to raiſe the whole of it above the water.

that will hold 19 gallons, and 98 hundred parts, whose greatest hoop's diameter is 30 inches, when placed perpendicular to the vessel, shall touch the two ends of each diameter, the least diameter must be 18·236 inches, and depth 11·9104 inches.*

Mr. *Richard Ford* answer'd all the six questions in one copy of verses, which came too late to be inserted.

Answer to the Prize Question.

To the prize question proposed last year, I received a considerable number of answers; but the difference among authors concerning the specifick gravity of metals, and the various theorems by which they found the content of the cask, and its vacuity, caused some (tho' inconsiderable) difference. It would be endless, as well as needless, (in my small room) to give you an account of the whole operation, which could not well be explain'd without a figure of the spheroid, and the algebraick theorems deduced therefrom, and would thereby be troublesome, as well as uncommon in a work of this nature; I shall therefore omit that, and only incert so much as answers the demands in the question.

Mr.

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* VI. QUESTION 40. *solved.*

Put $2a = 30 =$ the bottom diameter, $2x =$ the top diameter, and $A =$ the content in ale gallons. Then, by the nature of the circle, $\sqrt{aa - xx} =$ the perpendicular depth; and, by page 159 Mensuration, we have $4 \times \overline{aa + ax + xx} \times \sqrt{aa - xx} \times \frac{\cdot 78539 \text{ \&c.}}{3} = 282A$, where $282 =$ the inches in a gallon; or $\overline{aa + ax + xx} \times \sqrt{aa - xx} = \frac{846A}{3\cdot 14159 \text{ \&c.}}$. Now when $A = 19\cdot 98$ as in the question, there is no number, taken as the value of x, will produce so great a content, the number $19\cdot 98$ being above the maximum. But to find the greatest content the case will admit of, put the fluxion of $\overline{aa + ax + xx}|^2 \times \overline{aa - xx} =$ to nothing, and we shall have $0 = \overline{aa - xx} \times \overline{a + 2x} - x \times \overline{aa + ax + xx} = a^3 + a^2 x - 2ax^2 - 3x^3$; or in numbers $x^3 + 10x^2 - 75x - 1125 = 0$; or, putting $z = \frac{1}{5}x$, $z^3 + 2z^2 - 3z + 9 = 0$; the root z of this equation is $= 1\cdot 9394$; consequently $2x = 10z = 19\cdot 394 =$ the value of the less diameter when the content is a maximum; and then the depth $\sqrt{aa - xx}$ is $= 11\cdot 444$, and the greatest content $=$ $\overline{30^2 + 30 \times 19\cdot 349 + 19\cdot 349^2} \times \frac{11\cdot 444}{3} \times \frac{\cdot 78539 \text{ \&c.}}{282} = 19\cdot 739$ ale gallons.

Mr. *John Newbold*, and Mr. *John Edens*, have geometrically demonſtrated, and algebraically wrought each demand. An abſtract of which follows after Mr. *Edens'* anſwer in verſe.

To the ingenious ſons of art I write,
Who in the mathematicks take delight.
To cenſure others 'tis not my intent,
But to the gauger my reſpects preſent.
Hard was his fate that he this barrel found,
Such are not common in a gauger's round;
For if they were, others as well as he,
Would often at their *ne plus ultra* be:
At his requeſt I here ſend my aſſiſtance,
And from each head to th' bung the diſtance,
And what the barrel holds I make appear,
And what remains, tho' vulcan's craft was there.
Now ſince this taſk did poſe the gauger ſo,
Pray ſhew to him what I have done below.

	inches
The ſpheroid's greateſt diſtance from bung to head	12·053
The leſſer diſtance — — — — —	8·547
The content of the caſk in ale gallons — —	20·763
The iron ball equal to cubick inches — —	217·048
The leaden ball — — — — —	219·717
The caſk's vacuity — — — —	117·814
The box emerged — — — —	1723·000
The ſum, cubick inches — — —	2277·579
which are equal to ale gallons	8·076
which deducted from the whole content leaves	12·687

ale gallons, the true quantity of liquor remaining in the caſk.

At drawing the lots, Mrs. *Anne Morgan* won the prize.

Mrs. Mary Nelſon, *of Newmarket, anſwers thus.*

Alas poor man! you're in a ſad condition;
Who can refuſe to anſwer your petition?
If th' ladies grant you not relief with ſpeed,
You may at laſt be ſo reduc'd indeed
To ride like Hudibras, on ſuch a ſteed.
But ſince you are in ſuch a pitious caſe,
For once, I'll ſave your credit and your place:
Here underneath I've anſwer'd all your queries,
Which gives me one fair chance to win the diaries.
(Here follow'd the anſwer as above.)

Mr.

Mr. William Crabb's *anſwer to the Prize Queſtion.**

Why muſt ladies turn gaugers, unleſs't be for wagers,
And ſave a young man from undoing:
Muſt they be frightned all, with bullets and ball,
And a cube too; but this enſuing,
May make it more eaſie, if it may pleaſe ye,
To take care of miſtakes in the matter:
For the cube I do fear, had no part in the air,
Nor room to ſwim, kept it under water.
(*Reſponſ. ut ſupra.*)

The

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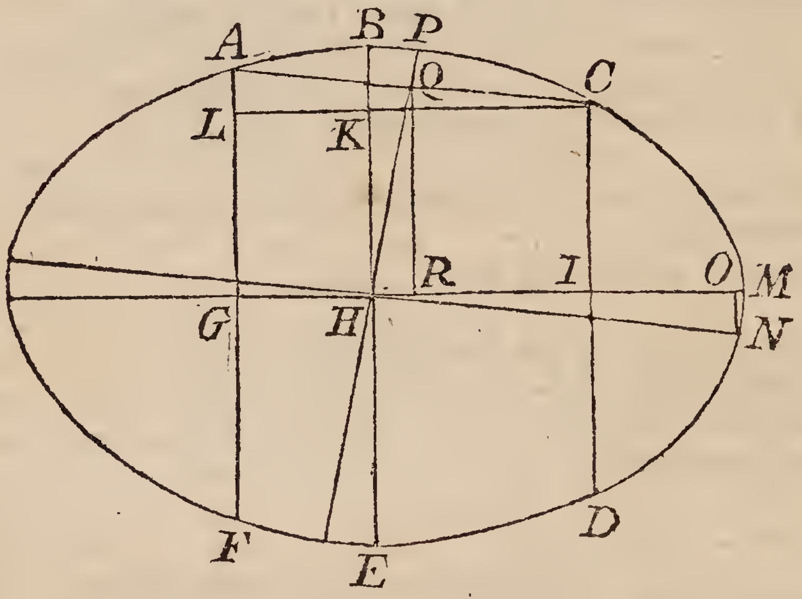
* PRIZE QUESTION *ſolved.*



Let $ACDF$ be the caſk, BE the conjugate axe, and HM the ſemitranſverſe; $CL \parallel$ to HM, $HN \parallel$ to AC, HQP the ſemi-conjugate of HN, and NO and $QR \parallel$ to BE.

By the nature of the ellipſe, we have

$\sqrt{HB^2-GA^2} : \sqrt{HB^2-IC^2} :: LK : KC$; and, by compoſ. &c.

$\sqrt{HB^2-GA^2}+\sqrt{HB^2-IC^2} : LC \; (=LK+KC)$

$$:: \left\{ \begin{array}{l} \sqrt{HB^2-GA^2} : LK = \dfrac{LC \times \sqrt{HB^2-GA^2}}{\sqrt{HB^2-GA^2}+\sqrt{HB^2-IC^2}} \\ = \dfrac{20{\cdot}6 \times \sqrt{10^2-9{\cdot}05^2}}{\sqrt{10^2-9{\cdot}05^2}+\sqrt{10^2-8^2}} = 8{\cdot}5463. \\ \sqrt{HB^2-IC^2} : KC = \dfrac{LC \times \sqrt{HB-IC^2}}{\sqrt{HB^2-GA^2}+\sqrt{HB^2-IC^2}} \\ = \dfrac{20{\cdot}6 \times \sqrt{10^2-8^2}}{\sqrt{10^2-9{\cdot}05^2}+\sqrt{10^2-8^2}} = 12{\cdot}0537. \end{array} \right.$$

And,

The Prize Queſtion anſwered by R. Sandford.

Well, look you here good queſtion ſpoil'd,
 Cot knoſe was nere ſee like, ſir;
Was put good ale for verjuice, child,
 Splut was in a paſſion ſtraight, ſir.

(*The anſwer as above.*)

Beſides

And, $\sqrt{EK \times KB} : KC :: BH : HM = \frac{BH \times KC}{\sqrt{EK \times KB}} = \frac{120{\cdot}537}{6} = 20{\cdot}0895.$

Alſo, by right-angled Δs, $AC = \sqrt{CL^2 + LA^2} = \sqrt{20{\cdot}6^2 + 1{\cdot}05^2} = 20{\cdot}62674$; and ſine of $\angle ACL = \frac{LA}{AC} = {\cdot}0509048 =$ ſine $\angle NHM$, which put $= s$, and its coſine $= c$.

Then, by the nature of the ellipſe,

$MH^2 : HB^2 :: MH^2 - HO^2 : ON^2$;

but $HO = HN \times c$, and $ON = NH \times s$, wherefore

$MH^2 : HB^2 :: MH^2 - HN^2 \times c^2 : HN^2 \times s^2$, or by ſubtraction

$MH^2 - HB^2 : HB^2 :: MH^2 - HN^2 \times \overline{s^2 + c^2} : HN^2 \times s^2$, or ſince $s^2 + c^2 = 1$

$MH^2 - HB^2 : HB^2 :: MH^2 - HN^2 : HN^2 \times s^2$, or

$\overline{MH^2 - HB^2} \times s^2 : HB^2 :: MH^2 - HN^2 : HN^2$, and by addition

$\overline{MH^2 - HB^2} \times s^2 + HB^2 : HB^2 :: MH^2 : HN^2$, and hence

$$NH = \frac{MH \times HB}{\sqrt{HB^2 + s^2 \times \overline{MH^2 - HB^2}}} = \frac{MH \times HB}{\sqrt{HB^2 \times c^2 + MH^2 \times s^2}} = 20{\cdot}01094.$$

Alſo, its ſemi-conjugate $PH = \sqrt{MH^2 + HB^2 - HN^2} = 10{\cdot}15629$.

But $HR = \frac{IH - GH}{2} = 1{\cdot}7537$; and $RQ = \frac{GA + IC}{2} = 6{\cdot}525$; and, by right-angled triangles, $HQ = \sqrt{QR^2 + RH^2} = 8{\cdot}703511$; conſequently $QP = PH - HQ = 1{\cdot}45278$.

Then,

Besides the above-specify'd, these following answer'd it: Mrs. *B. Sidway*, Mr. *N. Stephens*, Mrs. *Staples*, Mr. *John Whittingham*, Mr. *Boswell*, Mr. *Ford*, Mr. *Berriste*, Mr. *T. Fenton*, *Const. Love*, Mrs. *Hill*, and Mr. *Mouse*.

You tell us a tale of a tub of good ale,
That can buoy up the box in the liquor;
But 'twas fill'd with rum, or else sure with mum,
Or something still stronger and thicker.

The Eclipses of this Year.

Twice this year, 1715, shall the earth in part be deprived of the sun's illuminating radiancy, by the interposition of the opacous body of the moon; and twice also shall the moon be deprived in part of her sun borrow'd lustre, by reason of the earth interposing between the sun and her.

The first is a great eclipse of the sun, on friday the 22d of april, at 9 in the morning; visible to us in England.

The

Then, by cor. 2 page 275 Mensuration, the content of the segment APC will be $3\cdot14159$ &c. $\times MH \times HB^2 \times QP^2 \times \frac{HP - \frac{1}{3}PQ}{PH^3} = 122\cdot9787$ inches $=$ the vacuity.

But the content of the box cube is $12^3 = 1728$; all of which will be immersed, because it is heavier than ale. Also, using Ward's table of specific gravities, the solidity of the iron ball will be $\frac{60 \times 16}{4\cdot422979} = 217\cdot0483$; and that of the leaden one $\frac{90 \times 16}{6\cdot553885} = 219\cdot717$.

The sum of these three added to the above segment, gives $2287\cdot744$ for the sum of the deductions.

Now the content of the whole cask is $\overline{2EB^2 + FA^2} \times \cdot2618 HG + \overline{2EB^2 + CD^2} \times \cdot2618 HI = \overline{2EB^2 \times GI + FA^2 \times HG + CD_2 \times HI} \times \cdot2168 = 5855\cdot3142$.

From this whole content then taking the above sum of the deductions, we obtain $3567\cdot5702$ inches; which divided by 282, we have $12\cdot65096$ for the number of gallons required.

	d.	h.	m.	s.
The equal time of the true ☌ at ~~Coventry,~~ London april	21	21	17	7
The time of reduction ſubtract. — —			3	12
Equal time of the true conjunct. of the ecliptick		21	13	55
The equation of time add. — — —			16	23
The apparent time of the true ☌ — —		21	30	18
Interval of the true and viſible ☌ ſubt. —			19	57
Interval of the viſ. ☌ and greateſt ob. ſub. —				2
The hourly motion of the ☽ from the ☉ —			35	26
The beginning of the eclipſe 22d apr. morn.		8	6	6
The beginning of total obſcuration — —		9	9	3
The middle or greateſt obſcuration — —		9	10	19
The viſible conjunction — — —		9	10	21
The end of total obſcuration — —		9	11	36
The end or full recovery of ſun's light —		10	19	9
The whole duration — — — —		2	13	3

The

* This eclipſe was obſerved in England as here follows.

Places	Obſervers	Begin.	Immer.	Emers.	Tot.	End.
		h. m. s.	h. m. s.	h. m. s.	m. s.	h. m. s.
Barton	M. Bridges				3 53	
Bell bar	M. Jones	8 6 25	9 9 45	9 13 27	3 42	
Broadway } Carmarth. }			8 47 0	8 49 30	2 30	10 21 57
Cambridge	M. Cotes			9 14 37		10 24 30
Canterbury	M. Gray	8 10 0				
Cheſter	M. Ward	7 57 40				10 6 35
Crew	M. Wright		9 2 8		2 0	10 9 0
Dublin	L. Archbiſh.	7 42 11				9 49 40
Dublin	M. Hawkins	7 41 30				9 48 45
Exon	L. Biſhop		8 55 0	8 59 0	4 0	10 0 0
Exon	M. Hudſon	7 47 30			3 30	10 0 30
Greenwich	M. Flamſteed				3 11	
King's Wald.	M. Whitſide				3 52	
Llanidan } Angleſey }	M. Rowland	7 52 30				
London	R. Society	8 6 0	9 9 3	9 12 26	3 23	10 20 0
Northamp.	M. Hawkins		9 5 22	9 9 24	4 2	10 15 35
Norton-court	D. Harris	8 8 55	9 13 23	9 14 22	0 59	10 24 47
Oxon	D. Keill				3 30	10 15 10
Plymouth	M. Heines	7 41 0	8 45 30	8 50 0	4 30	9 54 30
Portcheſter	C. Chandler		9 2 25	9 6 15	3 50	
Salop	D. Hollings	7 58 0			1 40	10 6 0
Upminſter	M. Derham	8 7 41	9 10 58	9 14 6	3 8	10 21 45
Wanſted	M. Pound	8 6 37	9 9 28	9 12 48	3 20	10 20 32
Weymouth	M. Hobbs		8 53 0	8 58 0	4 0	
Witley	M. Baxter	7 59 0			3 15	10 13 0

The digits eclipſed are 12d. 10m. 16s.
The lat. of the moon ſeen at the begin. 0′ 20″ ſouth aſc.
The lat. of the moon ſeen at the end, 0′ 50″ north aſc.*

This eclipſe will be central in the nonageſime degree, in the lat. 59′ 54″ north, and long. eaſtward from Coventry 10′ 30″ in the ſouth eaſt parts of Norway.

The ſecond eclipſe is of the moon, on ſaturday the 7th day of may, half an hour after 1 in the afternoon; ſo inviſible to us.

The third is a ſolar eclipſe, falling on ſunday the 16th day of october, at 11 in the morning.

The fourth is a viſible eclipſe of the moon, monday october the 31ſt, at 4 in the morning.*

The

The center of the ſhade entered England about Plymouth, and paſſed over Exeter, the Devizes, Iſlip, Buckingham, and Huntington, leaving Oxford and Bedford on the right, and Lynn on the left, and quitted the coaſt of Norfolk about Wells and Blakeney. Its courſe making an angle of 52° 45′ with the meridian eaſtwards from the north. And its velocity 29 geographical miles in a minute of time very nearly.

In ſome other places it was thus obſerved.

Places	Obſervers	Begin.	Greateſt Obſcurity	End	Quant. eclipſ.
		h. m. s.	h. m. s.	h. m. s.	dig. ′
Paris	R. Academy	8 11 0		10 28 0	
Nurenburg				11 10 12	
Hamburg		8 57 0	10 5 30		11 30
Kiel in Holſt.		9 14 0	10 19 20	11 29 0	11 20
Berlin	J. H. Hoffman		10 22 0	11 34 1	11 0
Franckfort		8 50 0	10 0 1	11 10 0	10 34
Pirna	D. Schmiderus	9 15 0	10 30 0	11 32 0	10 0
Dantzick		9 40 2		12 2 40	
Warſaw		9 49 0			
Parma	P.A.Beccadelli	8 45 5		11 0 45	

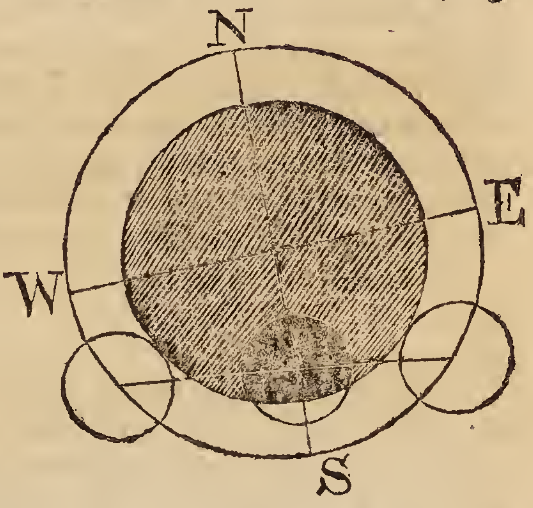
* This eclipſe was obſerved at *Wanſted* by Mr. *J. Pound* thus.

App. time	
h. m. s.	
15 9 0	The eclipſe had been for ſome time begun.
16 15 47	The middle.
17 38 20	The end.

The digits eclipſed were 8¾. The moon's diameter 33′ 40″.

	d.	h.	m.	s.
The equal time of the true oppoſition at Coventry, october — — —	30	16	16	31
The time of reduction add. — — —			2	56
The correct time of the true oppoſition in the ecliptick — — — —		16	19	27
Equation of time add. — — —			3	56
The apparent time of the oppoſition — —		16	23	23
Interval of the true ☍ and greateſt obſc. s.			5	52
The beginning the 31ſt october, morning —		2	58	29
The middle or greateſt obſcuration — —		4	19	31
The end at — — — — —		5	36	33
The whole duration — — — —		2	38	4
The digits eclipſed 7 d. 51 m. 19 s. nor.				
Latitude of ☽ ſouth deſc. at the beginn.			35	43
Latitude of ☽ ſouth deſc. at the end			44	25

A type of the lunar eclipſe the 31ſt of october, a quarter after 4 in the morning.



I gave you an account laſt year, that the ſun's eclipſe on the 22d of april, is the greateſt that (I can find) has happened in England theſe 60 years, or perhaps a much longer time, or that will happen for ſo long yet to come. I do not find that anno 1653, was total.

There will be two very large eclipſes of the ſun, one on the 11th of may, 1724, at 6 at night; the other on the 14th of july, 1748, between 10 and 11 in the morning. There will, before the year 1762, be 16 total eclipſes of the moon, and 31 partile eclipſes. As alſo 15 viſible eclipſes of the ſun, 9 of which will be very conſiderable ones; an account of theſe you may meet with in ſome of my next.

Of the excellency and uſefulneſs of Mathematical Learning.

In all ages and countries where learning hath prevail'd, the mathematical ſciences have been looked upon as ſome of

the chief and moſt conſiderable branches of it. And amongſt the ſeven liberal arts, no leſs than four of them are mathematical; namely, arithmetick, geometry, muſick, and aſtronomy. There is no ſcience in the world, that does improve the mind of man, ſo much as this; by giving it a habit of cloſe and demonſtrative reaſoning; by freing it from credulity, prejudice, and ſuperſtition; by rend'ring it exact, and capable of ſolving the greateſt difficulties; and laſtly, by regulating the imagination, and giving the mind the greateſt extenſion and capacity that human nature is capable to attain.

The uſefulneſs of this ſcience is almoſt infinite, there being ſcarce any knowledge, art, or ſcience in the univerſe, but may be aſſiſted and advanced by it. And indeed it is to this ſcience we owe the vaſt improvements of natural knowledge in theſe laſt ages, and ſome of the moſt noble inventions of the world.

Arithmetick is an art more liberal than all the reſt, for it makes ready payment for our diligence, in that it inſtantly gives the demonſtration of its operations, and ſets no leſſon which does not at the ſame time diſplay the perfection of its ſecrets. It has this in particular, That you may find in each of its operations, that perfection which is vainly ſought for in the whole circle of other arts.

Without it trade would go near to ruin: What would become of the nation, if by it were not kept the public accounts that regard the ſtate of the common-wealth, as to the number, fructification of its people, increaſe of ſtock, improvement of lands and manufactures, ballance of trade, publick revenues, coinage, military power by ſea and land? Of which no perſon can truly judge without ſubjecting them to calculation.

Is it not by this and geometry, that all menſurations of plains, as board, glaſs, painting, &c. and ſolids, as timber and ſtone, are performed, and ſold by meaſure as well as cloth. Workmen are paid the due price of their labour, according to the ſuperficial or ſolid meaſure of their work. And the quantity of liquor determined, for a due regulation of their price and duty.

By theſe and trigonometry are performed thoſe uſeful parts, as meaſuring acceſſable and inacceſſable heights and diſtances by ſea and land, laying down plans of particular lordſhips, incloſures, and taking maps of countries. What fortifying, attacking, defending, bombing, mineing, or quartering and embatailing of armies, could be performed without the aſſiſtance of arithmetick and geometry? How is it but by theſe arts, that building of houſes and ſhips, the making of teleſcopes, microſcopes, ſpectacles, and all other optick glaſſes; the calculating of clocks, watches, and ſun-dials, and all mechanick

mechanic engines and inſtruments, are demonſtrated and made?

Nor is its uſe leſs inferior by ſea in the art of navigation, on which the riches and ſecurity of the kingdom depend. How vain and unſucceſsful would the merchant's pretenſions be to fetch home riches from any part of the world? Could the navigator ever hope to find his way (after a ſtorm) by ſea, without the help of aſtronomy, to know longitude and latitude, by the ſun, moon, and ſtars, and the other planets and their ſatellites in the obſervation of their diſtances, oppoſitions, conjunctions, eclipſes, riſing, ſetting, culminating, &c.

Our ignorance of the ebbing and flowing of the tides would argue a want of aſtronomy, as alſo the times and ſeaſons of the year, the obſervation of the feſtivals and faſts of the church, according to the firſt primitive inſtitution, could not be kept to a due diſpoſition, as to the return of the ſeaſons and the ſun's motion.

Nothing ſurely can more illuſtrate and give greater life and glory to aſtronomy, and animate its profeſſors, than the generous encouragement her late ſacred majeſty and parliament have now been pleaſed to give, by ſettling a reward of twenty thouſand pounds, on ſuch perſon or perſons as ſhall diſcover a more certain and practicable method of aſcertaining the longitude, than any yet in practice. And although aſtronomy is in theſe days arrived to a great perfection, yet are there (I doubt) wanting a long ſeries of obſervations of the heavenly bodies, to effect the ſame.

It was the opinion of ſome about 1630, that longitude might be found by the obſervation of ſomething below the moon. In purſuance whereof, Mr. *Henry Bond*, a mathematician, after 38 years ſtudy and obſervation in 1676, publiſhes a treatiſe, entituled, *Longitude found, by the magnetick inclinatory needle;* which was by his majeſty's appointment examined by ſix commiſſioners, celebrated men of their time, *viz.* Seth, Lord Biſhop of Sarum, the Lord Brunker, Sir Samuel Morland, Col. Titus, Dr. Pell, and Mr. Hook; and was farther confirmed by ſeveral obſervations in the ſtreights of Magellan; for encouragement of which, his majeſty king Charles II. was graciouſly pleaſed to grant his royal licence for publiſhing the ſame, with privilege for 15 years, dated 28th june, 1676. But it ſeems this fell ſhort of its end, as all the methods of our modern pretenders to longitude have yet done. I heartily wiſh it may be the glory of our age to find the ſame.

But as 'tis needleſs to ſay thus much of a ſcience that illuſtrates its uſes and perfections daily, I can but admire who would be ignorant of its excellency, uſe, and benefit to mankind?

mankind? Who would not take ſome pains, to attain a competent knowledge of an art ſo truly valuable? I am confident there is no thoughtful and contemplative perſon but would find pleaſure and ſatisfaction in the ſtudy of it. 'Twas from theſe conſiderations, that in my vacant hours I have (tho' meanly) endeavoured to introduce ſome parts of it into the world, by the enſuing method.

Some Paradoxes propoſed, to be anſwered next year.

A paradox is a ſeeming falſity, but a real truth; it is that which to unthinking perſons ſeems abſurd, or impoſſible, but to a thoughtful man is plain and evident; the main drift whereof is to whet the appetite of an inquiſitive learner, and ſet him upon thinking. Although (ſays an ingenious author) the ſoul of man is a cogitating being, and its thoughts ſo nimble as to ſurround the univerſe itſelf in a trice; yet ſo unthoughtful, and ſtrangely immur'd in ſenſe, are the generality of perſons, that they need ſome ſtartling noiſe to rouſe and awake them.

The propoſing a paradoxial truth to the intellect, immedidiately ſummons all the powers of the ſoul together, and ſets the underſtanding on work to ſearch into, and ſcan the matter. 'Tis no trivial buſineſs to awaken the mind of man to its natural act of thought and conſideration. If therefore theſe enſuing paradoxes ſhall obtain this end, it matters the leſs if ſome of them, upon ſtrict enquiry, ſhould be found to conſiſt of equivocal terms, or perhaps prove little more than a quibble at the bottom.

1. *A Paradox by Mr.* Moyle.

Chriſtians the week's firſt day for ſabbath hold;
The jews the ſeventh day (as they did of old);
The turks the ſixth (as I have been told).
Now, good ſir, pray tell to me,
How it is poſſible this thing can be,
That ever a chriſtian, jew, and turk, theſe three
Being all together in one place, may,
In and upon one and the ſelf-ſame day,
Have each his own true ſabbath? tell, I pray.

Some Geographical Paradoxes from an ingenious author.

Par. 2. There is a particular place of the earth, where the winds (tho' frequently veering round the compaſs) do always blow from the north point.

Par,

Par. 3. There is a certain hill in the ſouth of Bohemia, on whoſe top, if an equinoctial ſun-dial be duly erected, a man that is ſtone blind may know the hour of the day by the ſame, if the ſun ſhines.

Par. 4. There is a vaſt country in Ethiopia ſuperior to whoſe inhabitants the body of the moon doth always appear to be moſt enlighten'd when ſhe's leaſt enlighten'd; and to be leaſt when moſt.

Par. 5. There's a large and ſpacious plain in a certain country in Aſia, able to contain ſix hundred thouſand men drawn up in battle array; which number of men being actually brought thither, and there drawn up, it was abſolutely impoſſible for any more than one ſingle perſon to ſtand upright upon the ſaid plain.

Par. 6. There are three diſtinct places on the continent of Europe, equidiſtant from one another, (they making a true equilateral triangle, each of whoſe ſides doth conſiſt of a thouſand miles) and yet there is a fourth place ſo ſituated in reſpect of the other three, that a man may travel on foot from it to any of the other three, in the ſpace of one artificial day at a certain time of the year, and that without the leaſt hurry or fatigue whatſoever.

New Queſtions.

I. *Queſtion* 41, *by Mr.* Dod.

A rakiſh ſpark the other night,
  (Who had learn'd ſome algebra)
Came home half drunk, as well he might,
  From tippling all the day.
His uncle chid him, and complain'd,
  He'd run thro' his eſtate,
And aſk'd what he that day did ſpend;
  To which he anſwer'd ſtreight,
The pence ſquar'd and involv'd into
  Five times their own ſquare root,
Are pounds one hundred ſixty-two,
  Whence you may find it out.

II. *Queſtion* 42, *by Mr.* William Taylor.

As I was walking out one day,
Which happ'ned on the firſt of may,
As chance would have it, I did ſpy
A may-pole raiſed up on high,
The which at firſt me much ſurpriz'd,
Not being before-hand advertiz'd

Of

Of ſuch a ſtrange uncommon ſight,
I ſwore I would not ſtir that night,
Nor reſt content until I'd found
Its height exact from off the ground:
But when theſe words I juſt had ſpoke,
A blaſt of wind the may-pole broke;
Whoſe broken piece I found to be
Exact in length yards ſixty three;
Which by its fall broke up a hole,
Twice fifteen yards from off the pole;
But this being all that I can do,
The may-pole now being broke in two
Unequal parts: To aid a friend,
Ye ladies, pray an anſwer ſend.

III. *Queſtion* 43, *by Mrs.* Boydell.

An aged ſire, with his two daughters, came
To town, and was deſir'd to tell his name.
My name, ſays he, 's a thouſand more than you,
And I. and if you add the other two,
The number of this preſent year they'll ſhew.
The * numr'al letters of our names (well ſet
With the firſt letter of the alphabet)
Make ſeventeen hundred, and fourteen compleat.
I'll further add (to make the problem plain)
Each ſingle name five letters doth contain.

* D. *ſtands for* 500, C. *for* 100, L. *for* 50, V. *for* 5, I. *for* 1, &c.

IV. *Queſtion* 44, *by Mr.* T. Hayward.

Within my garden, lying on the ground,
A ſtone I've got, that weighs 300 pound:
A little barrow likewiſe, ſix foot long,
I've got; tho' little, it is very ſtrong.
Now, ſirs, becauſe the ſtone lay in my way,
I ſold it to a maſon yeſterday;
Who begg'd my barrow for to take it home,
And call'd his two men; preſently they come;
But one (being lately ſick) was very weak,
More than five ſcore he could not undertake.
How on the barrow muſt this ſtone be laid?
Pray tell me; for this fellow is afraid,
If he ſhould carry much, 'twould do him more
Diſkindneſs, than his ſickneſs did before.

V. *Queſtion* 45, *by Mr.* Tho. Shepheard.

Suppoſe the earthly ball's circumference
Be one and twenty thouſand miles in length,
Beſides ſix hundred more. I fain would know
How far the head of any one doth go
More than his feet; (but yet I muſt diſplay
The matter more, or you'll not find the way.)
One that's five foot and ſeven inches tall,
To go in length upon this earthly ball
Ten thouſand miles exactly: That is all.

VI. *Queſtion* 46, *by Mr.* Ed. Elphick.

Kind ſir, I pray, can you to me declare
A lofty tower's height within the air:
I'll tell you how the height you well may know,
Which in a problem unto you I'll ſhow.
If from the tower's height there ſhould be laid
A plain, whoſe ſurface fine and ſmooth is made,
To meet the earth; three hundred foot and four
From the foundation of this lofty tower;
And then a body which in pounds doth weigh
Juſt fifty ſix, you on the plain do lay;
Juſt forty pounds will the ſame ſuſtain,
From ſliding down on this deſcending plain.
But, artiſt, I apply myſelf to you,
(The tower's height) to calculate it true.

The Prize Queſtion.

When Phœbus had up-heav'd his golden head,
From the ſoft pillow of his ſea-green bed,
And with his riſing glory had poſſeſt
The ſpacious borders of th' enlighten'd eaſt:
In Albion's channel, off from the cliffs of Dover,
Where I could ſcan that famous channel over,
And make bright Callis ſhining in the eaſt,
Our ſhip then lying almoſt pointing weſt;
The day ſerene and fit for obſervation,
I ſent a ſhip to form a ſecond ſtation:
Then I obſerv'd my angles for to be
* Twenty four and eighty ſix degree;
And at my ſecond I the object ſees,
At † forty eight, a hundred twenty nine degrees.

* 24° *and* 86°. † 48° *and* 129°.

This

This being known, How far's each ſhip's from th' other?
Likewiſe, how far off Callis and off Dover?
But e'er the caſe determin'd will appear,
The following lines to you I muſt declare.
Being on Dover's beach an object I eſpy'd,
Which on a wave from Callis bank did glide.
In equal times it equal ſpaces run,
From whence its rapid motion firſt begun.
Forty five foot was each wave's true diſtance,
And in a line approaching me did dance;
* Two hours, twenty five minutes, ten ſeconds more,
Ten thirds, thirty three fourths (the wave did roar)
And thirty ſix fifths, is the true time I found,
From my firſt ſight to's breaking on the ground;
Which was the place I ſtood upon.
Now I would know how far the diſtance run.
Which being known (what undetermin'd were)
If rightly managed) true proportion bear.

* $2h.\ 25'\ 10''\ 10'''\ 33''''\ 36'''''$.

1716.

Anſwers to the Paradoxes propoſed laſt year.

Anna Philomathes *anſwer'd them all. To the firſt thus:*

FROM the place o'th' jews abode let the other two ſet out,
The chriſtian eaſt, the turk weſt, and ſail the globe about,
Then with the jew they'll agree when they again do meet,
And all upon the ſaturday will their true ſabbaths keep.

Paradox 2d anſwered, the South Pole.

Paradox 3d. If a burning glaſs be the nodus of a dial, and ſo contriv'd that the focus may fall on an iron or braſs plate or ring, on which the figures are deeply cut, a blind man may feel where the plate or ring is heated by the ſun, and which figure it is upon or neareſt to.

To the 4th paradox the ingenious Anna Philomathes *thus anſwers:* The light that falls upon any body, being always in a reciprocal duplicate ratio of the diſtance from the luminous body: hence it follows, that not only in Ethiopia, but in all parts of the world the moon doth always appear to be moſt enlightned, at the full moon, when ſhe's leaſt enlightned, becauſe ſhe is then removed from the ſun farther than at the new moon, by the diameter of the moon's orbit.

The

The 5th paradox anſwered, according to Euclid. A plane can touch a ſphere only in one point, call'd the contact, and that perſon only who ſtands to that point (with reſpect to the center of that ſphere) can ſtand upright.

The 6th paradox anſwer'd. By an artificial day is here meant from ſun-riſing to ſetting. And beyond the tropick, and nearer and nearer the poles, the days are increas'd when the ſun comes on that ſide the equator from 24 hours long to about 100 days long, the ſun neither riſing nor ſetting in that ſpace of time.

Mr. *Moyle anſwer'd* 2, 4, 5, 6; Mr. *Edens*, all; *Paſtora*, the firſt. Mr. *B. Graves*, 1, 2, 5. Mr. *Andrew*, 2, 5, 6. *John Hodge*, all. Mr. *Walker*, 2, 6. Mr. *Wylde*, 2, 6. Mr. *Coles*, 1. Mr. *Wentworth*, 2, 6. Mr. *Aſh*, 1. *Tho. Andrew*, 3, 6. *Tho. Coach*, 5, 6. *I. Richards*, 1, 2, 5. *R. Hall*, 1, 2. and *Cynthia Aris*, the firſt.

Solutions to the laſt year's queſtions.

* I. *Queſtion* 41, *anſwered by Mr.* Richard Sandford.

Well might his uncle blame the rakiſh ſot,
For ſpending thus three ſhillings at a ſhot;
Sure he'll no longer trifle time away,
But ſpend leſs in ale, more in algebra.

The ſame anſwer'd by Silvia.

Your algebraick, tipling ſpark,
Might well reel home, when in the dark;
I'll ſwear he was a learned blade,
And has a learned reck'ning made:
'Mongſt pot companions he's no fool,
Who ſcores by ſcale, and drinks by rule;
But to prevent his uncle's loſs,
I here explain the tippler's doſe. *Anſ.* 36 *pence.*

If the pence in 162 pound be b, and the pence ſpent be $= a$; then this theorem ſolves the queſtion $a = \sqrt[5]{\frac{b^2}{25}} = 36$.

II. *Queſ-*

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* I. QUESTION 41. *ſolved.*

Let x denote the pence ſpent. Then, by the queſtion $x^2 \times 5\sqrt{x} = 162 \times 240 = 38880$, or $x^2\sqrt{x} = 7776$; hence, by ſquaring, $x^4 \times x$ or $x^5 = 7776^2$; and conſequently $x = 7776^{\frac{2}{5}} = 36\,d. = 3\,s.$

* II. *Queſtion 42d, anſwered by Mr.* Joſ. Jeacock.

To aid a friend, I here intend,
The may-pole's height to ſhow,
So if you pleaſe, you may with eaſe
Thus view it here below. *Anſ.* 118·3985 *yards.*

This is found by the 47th theorem of 1 *lib. Euclid.*

III. *Queſtion* 43, *anſwered by* Philo Tipperus, *and Mr.* P. Proſon.

Whilſt Lidia for Lydai you cunningly write,
You think you may ſurely enſnare us; *David* 1006
But David is aged, and Lucia bright, *Lidia* 552
So 'tis eaſy to——Philo Tipperus *Lucia* 156
The daughters who to town with David came, ——
Lucia was one, and Lidia's t'other's name. *P. Proſon.* 1714

IV. *Queſtion* 44, *anſwered by* Silvia.

To eaſe the maſon's feeble man by true mechanick ſkill,
The ſtone upon the barrow plan thus to be plac'd I will;
Of gravity the center lay, juſt ſo much next the ſtronger,
That diſtance 'twixt the other may be two to one the longer.

In queſtions of this nature the reſult will be; the greater ſtrength multiply'd by the ſhorter length, is equal to the leſſer ſtrength multiply'd by the greateſt length; and here the barrow's weight is not accounted for, otherwiſe it would require ſome ſkill in ſtaticks to reſolve it.

V. *Queſtion* 45, *anſwered by* Silvia.

Your thought is odd, but juſt, the caſe is plain,
Our heads in haſte, outſtrip our heels;
And what in miles ten thouſand thus they gain,
(Unleſs the man be drunk or reels)
Without the help of magick or a ſpell,
In arithmetick numbers, I will tell.

'Tis

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* II. QUESTION 42. *ſolved.*

It is evident, from the queſtion, that the part broken off (63) is the hypothenuſe of a right-angled triangle, whoſe perpendicular is the part left ſtanding, and baſe equal to (30) the given diſtance which the top ſtruck the ground from the pole; and conſequently, by right-angled triangles, $\sqrt{63^2 - 30^2} = \sqrt{3069} = 55{\cdot}3985559$ = the part left ſtanding. To this adding 63 the part broken off, we obtain 118·3985559 for the whole length required.

'Tis evident in the caſe propoſed, that while the feet deſcribe an arch on the earth's ſurface equal to 10000 miles, the head will deſcribe a ſimilar arch of a circle, whoſe radius exceeds the ſemi-diameter of the earth 5 feet 7 inches: Therefore as the ſemi-diameter of the earth, is to the ſemi-diameter increaſed by 5 feet 7 inches: So is 10000 geographical miles, to an arch exceeding 10000 miles by 16·23 feet, according to *Van Culen*'s proportion of the diameter to the circumference, viz. as 1 to 3·14159265358979 3.*

VI. *The 46th Queſtion anſwered by the ſame, and Mr.* James Cole, *Mr.* Doidge, *Mr.* Edens, *Mr.* Willingham, *Mr.* Ronkſley, *Mr.* Wylde, Anna Philomatha, *Mr.* Richards, *Mr.* Bower, *&c.*

Your tower's lofty and ſublime,
Your problem rational and fine,
Your method's juſt, I like the notion,
Which joins with numbers, weight, and motion;
But ſure it is contriv'd to vex
Our uninſtructed, ſofter ſex:
You try our weakneſs, ſearch out flaws,
By algebra and ſtatick laws;
Yet to untie your curious knot,
Since 'tis a homely virgin's lot,
Pleaſe to accept my kind, officious aid,
Who am a rural and mechanic maid.

By a known principle in mechanicks, the accelerating velocity, or weight of bodies on an inclin'd plane, is to their accelerating velocities or weight in their perpendicular deſcent, as the ſign of the angle of inclination, to the radius; or as the perpendicular to the length of the plane, conſider'd as an hypothenuſe; and therefore in this the proportion of the

* V. QUESTION 45. *ſolved.*

Since the earth's radius is $\frac{21600}{2 \times 3{\cdot}14159 \, \&c.}$ inches, and 5 feet 7 inches = 67 inches; by ſimilar ſectors, as radius : radius + 67 :: 10000 : 10000 + the exceſs travelled by the head; or, by diviſion, as radius : 67 :: 10000 : the ſaid exceſs; that is, as $\frac{21600}{2 \times 3{\cdot}14159 \, \&c.} : 67 :: 10000 : \frac{10000 \times 67 \times 2 \times 3{\cdot}14159 \, \&c.}{21600}$ $= \frac{6700 \times 3{\cdot}14159 \, \&c.}{108} = 194{\cdot}8951$ inches $= 16{\cdot}2412$ feet = the exceſs required.

the perpendicular, and the length of the plane, being given as 40 to 56, or as 1 to 1·4. Let the perp. fought be $= x$, the hypothenufe will be $1·4\,x$, and the bafe 304 feet $= a$, then, $1·96\,x^2 - x^2 = 0·96\,x^2 = a^2$ by 47 Euclid 7. and by divifion and evolution.

$$x = \overline{\frac{aa}{0·96}}\Big|^{\frac{1}{2}} = 310·27 \text{ feet required.*}$$

Here follows the anfwers of two ingenious perfons to all the 6 queftions, in one copy of verfes.

Mr. C. Mafon, *from Northumberland.*

The rakifh fpark three fhillings fpent, *Queft.* 41.
  If that I took it right;
Which having done, he fwagg'ring went,
  And took the may-pole's height;
Which was in yards, fivefcore eighteen, 42.
  And nigh four-tenths, I fay;
But David the like ne'er had feen, 43.
  Lydia nor Lucia.
Then take one-third o'th' barrow's length, 44.
  And thereon lay the weight,
'Caufe the one exceeds a third in ftrength,
  'Twill counterpoize them right:
Then fixteen feet one quarter more, 45.
  Let them bear it away,
Or feet three hundred and ten, fome o'er 46.
  They there may let it ftay.

Mr. *Fran. Walker*, of Lynn, in this method anfwer'd all fix; as did Mr. *Ambrofe Gilbert*, except the 46th queftion. I am

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* VI. QUESTION 46. *folved.*

It is evident that this problem may may be eafily *Conftructed* thus: Make a right-angled triangle whofe hypothenufe and perpendicular are 56 and 40, or 7 and 5, or any two numbers proportional to thefe; then make another fimilar triangle whofe bafe may be 304; and its perpendicular will be the height of the caftle required.

And from the fame principle, the *Calculation* may be given without algebra, thus: Since $\sqrt{7^2 - 5^2} = \sqrt{24}$ = the bafe of the firft triangle to which the other is fimilar, we fhall have as $\sqrt{24} : 5 :: 304 : \frac{304 \times 5}{\sqrt{24}} = \frac{304}{\sqrt{·96}} = \frac{760}{\sqrt{6}} = 310·2687$ = the caftle's height.

I am ſorry no other perſons that have truly anſwer'd them ſingly, would take the pains to put their anſwers into one ſhort copy that might have had a place here.

*The Prize Queſtion anſwered.**

To this queſtion, beſides abundance of falſe anſwers, I received ten true ones, and becauſe I ſee ſo few amongſt ſo many ingenious correſpondents, I am apt to believe it was as difficult, as 'twas an uncommon queſtion; for which reaſon I ſhall here give you the ſolution, and the algebraick method by which the ſame is found.

Sir *Iſaac Newton*, in his *Principia*, ſays, Let there be a pendulum, whoſe length from the point of ſuſpenſion, to the center of obſcillation, is the breadth of any wave; then while the pendulum makes an obſcillation, the wave will paſs over a diſtance equal to its breadth. From which, and the nature of pendulums, is raiſed the following theorem.

Let

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* *The* PRIZE QUESTION *ſolved*.

Perhaps the ſolution will appear a little clearer thus: Put $p =$ 39·2 inches the length of the pendulum, $v = 60$ the number of vibrations it makes in a minute, $b = 45$ feet the breadth of a wave, and $t = 145·1696$ minutes the given time. Then, by the nature of pendulums, $\sqrt{12b} : \sqrt{p} :: v : v\sqrt{\frac{p}{12b}} =$ the number of vibrations made in a minute by the pendulum whoſe length is the breadth of a wave; but for every vibration the wave will paſs over a diſtance equal to its breadth b; hence the wave moves over $bv\sqrt{\frac{p}{12b}}$ or $v\sqrt{\frac{bp}{12}}$ feet in each min. which therefore drawn into t minutes makes $tv\sqrt{\frac{bp}{12}} = tv\sqrt{\frac{45 \times 39·2}{12}} = tv\sqrt{15 \times 9·8} = 7tv\sqrt{3} = 145·1696 \times 420\sqrt{3} = 105605·2$ feet $= 20$ miles nearly $=$ the diſtance between Calais and Dover.

This diſtance being obtained, which is the ſide CD of a quadrilateral $ABCD$, of which the angles formed by the oppoſite ſide AB with the two diagonals BD, AC, as alſo with the other two ſides AD, BC, being given, the figure will be *Conſtructed* (as in the Britiſh Oracle) thus:

At the extremities A, b, of any line Ab, make the angles bAc, bAd, Abc, Abd equal to the given angles, and join c, d; ſo ſhall $Abcd$ evidently be a quadrilateral ſimilar to *that* formed by the two towns and two ſhips; and, conſequently, if dc be produced to E, till dE be equal to 20 the given diſtance between Calais and Dover,

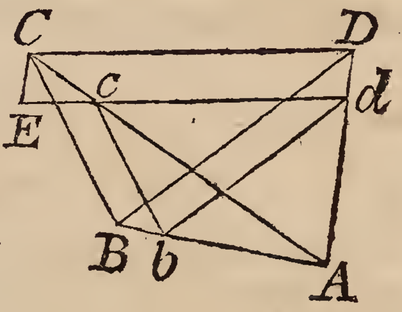
and

Let the diſtance run be $= a$, the length of a ſtandard pendulum $= p = 39 \cdot 2$ inches; the ſquare of the vibrations in a minute $= f = 3600$, $s = 45$ feet or 540 inches, the breadth of the wave, and $t = 2$ hours 25 min. &c. $= 145 \cdot 1696$ minutes, alſo $r = 45$ feet: then $s : p :: f : \frac{pf}{s}$; but $\sqrt{\frac{fp}{s}}$ = to the number of vibrations it will make in a minute, and multiplied by r will be the feet the wave will move in a minute; but $\frac{a}{r\sqrt{\frac{pf}{s}}} = t$, and conſequently, by reduction, $a =$ $rt\sqrt{\frac{pf}{s}} = 105600$ feet $=$ 20 miles ſought, or the diſtance from Calais to Dover.

In this following figure *C* repreſents Calais, *D* Dover, *A* the firſt ſhip, *B* the ſecond.

Then

From:
- Cal. to Dov. *C* to *D* 20 mil.
- Dov. to 1ſt ſh. *BA* 13·5192
- Dov. to 2d ſh. *DB* 18·1583
- Cal. to 1ſt ſh. *CA* 22·4008
- Cal. to 2d ſh. *CB* 11·7238
- 1ſt ſh. to 2d ſh. *AB* 13·0853



The angles *DAB* 86°, *CAB* 24°, *DBA* 48°, *CBA* 129°.

Mr. *William Hawney*, (who won the prize of 10 diaries) Mr. *John Edens*, *A. Philomathes*, Mr. *James Mouſe*, Mr. *Stephens*,

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and *EC* be drawn parallel to *Ad* and meeting *Ac* in *C*, that then *CB*, *CD* being drawn parallel to *cb*, *cd*, and meeting *Ab*, *Ad* in *B* and *D*, the points *A*, *B* will be the two ſhips, *C* Calais, and *D* Dover.

The *Calculation* from this conſtruction is alſo evident: viz. aſſuming *Ab* = any number, as ſuppoſe 10, in the two triangles *Abc*, *Abd*, we have given all the angles and the ſide *Ab*, to find the other ſides; and hence thoſe ſides are *Ac* = 17·11811 miles, *bc* = 8·95914 miles, *Ad* = 10·33093 miles, and *bd* = 13·86777 miles. Then in the triangle *bcd* are given two ſides with their included angle, to find the third ſide *cd*, which will be = 15·28859 miles. Laſtly, by ſimilar triangles, as *cd* = 15·28859 : *CD* = 20

:: {
Ab = 10 : *AB* = 13·08165,
Ac = 17·11811 : *AC* = 22·39331,
Ad = 10·33093 : *AD* = 13·51456,
bc = 8·959144 : *BC* = 11·72004,
bd = 13·86777 : *BD* = 18·74133.

Stephens, Mr. *Stewart*, *T. W.* Mr. *James Pearſe*, and Mr. *Cha. Bower* anſwer'd this queſtion, as alſo Mrs. *Mary Nelſon* in the following verſe:

Maſter Tar, I proteſt I'm not pleas'd with your query,
You've ſent at this time to be ſolv'd in your diary,
Methinks it looks like an ill-natur'd demand,
To offer to puzzle us ladies at land;
Tho' I'm apt to believe, if a trial ſhould be,
That you'd puzzle us worſe if you had us at ſea:
But methinks I can gueſs how you ſparks are inclin'd,
You are always beſt pleas'd when the ladies prove kind;
Then to ſhew that we maids of this brave Britiſh nation,
Can act here at land, or at ſea on occaſion,
To each of your queries I've ſent you an anſwer,
And all of them right, then deny't if you can, Sir.

(*Here follow'd the anſwer.*)

Of the Perfection of Aſtronomy.

Having laſt year ſaid a word or two of the mathematics in general, I ſhall here handle them gradually: but as aſtronomy is the moſt noble and ſublime of all the parts, I ſhall at preſent confine myſelf to ſay ſomething of it. In which let us conſider, to what perfection we now know the courſes, periods, orders, diſtances, and proportions of the heavenly bodies, at leaſt ſuch as fall within our view. We ſhall have cauſe to admire the ſagacity and induſtry of the mathematicians, and the power of numbers and geometry well applied: if we caſt our eyes backwards, and conſider aſtronomy in its infancy, what a mean and inconſiderable figure did it make, to what it does in our days?

Let us ſuppoſe (ſaith an ingenious author) a colony of rude country people tranſplanted into an iſland, remote from the commerce of all mankind, without ſo much as the knowledge of the calendar, and the periods of the ſeaſons; without inſtruments to make obſervations, or the leaſt notion of them. When is it we could expect any of their poſterity ſhould arrive at the art of predicting an eclipſe? Not only ſo, but the art of reckoning all eclipſes that are paſt or to come, for any number of years? When is it we could ſuppoſe, that one of thoſe iſlanders, tranſported to any place of the earth, ſhould be able, by the inſpection of the heavens, to find how much he were ſouth or north, eaſt or weſt of his own iſland, and to conduct his ſhip back thither? For my part, though I know this may be, and is daily done, by what is known in aſtronomy, yet when I conſider the vaſt induſtry, ſagacity, multitude of obſervations, and other intrinſick things neceſ-

ſary for ſuch a ſublime piece of knowledge, I ſhould be apt to pronounce it impoſſible, and never to be hoped for.

Now we are let ſo much into the knowledge of the machine of the univerſe, and motion of its parts, by the rules of this ſcience, perhaps the invention may ſeem eaſy. But when we reflect, what penetration and contrivance were neceſſary to lay the foundation of ſo great and extenſive an art, we cannot but admire its firſt inventors: ſuch as *Thales Mileſius*, who predicted eclipſes, and his ſcholar *Anaximander Anileſius*, who found out the globous figure of the earth, the equinoctial points, the obliquity of the ecliptick, the principles of gnomonics, and made the firſt ſphere, or image of the heavens; and to *Pythagoras*, to whom we owe the diſcovery of the true ſyſtem of the world, and the order of the planets: tho' it may be they were aſſiſted by the Egyptians and Chaldeans. But whoever they were that firſt made theſe bold ſteps in this noble art, they deſerve the praiſe and admiration of all future ages.

Altho' the induſtry of former ages had (as I ſaid before) diſcovered the periods of the great bodies of the univerſe, and the true ſyſtem and order of them, and their orbits pretty near; yet were they very deficient in divers things.

The one was in the true calculations of eclipſes; for the beſt of them miſtook egregiouſly in them, making eclipſes when really there was none, and omitting them many times when the luminaries were really obſcur'd; and when they with difficulty hit upon the time pretty near, they were often out in the digits eclipſed, and ſometimes making one ſide of the ſun or moon dark, when really it proved to be the other. But the aſtronomers of our age have arrived at much greater perfection, eſpecially in the ſun's eclipſe (witneſs that great one laſt year) which is much more difficult than that of the moon; for an eclipſe of the moon has the ſame appearance to all its beholders; whereas that of the ſun may appear to one part of the earth totally eclipſed, to another part of the earth eclips'd but in part on its north ſide, to others eclips'd in part on its ſouth ſide, and to others not eclips'd at all; and all this at the ſame moment of time. So that an eclipſe of the ſun muſt be calculated for every individual place, if you have its true appearance, which cauſes it to be ſo difficult to perform, and made the ancients to err ſo very much in that particular. As an inſtance of our modern improvements, I will give you the calculations of two great eclipſes of the ſun, which are the greateſt that will happen in our iſland theſe 50 years yet to come, and tho' they happen not for ſeveral years, I doubt not but they that obſerve them, will find them exactly at the time here ſet down. They are calculated for the latitude of

of 52 deg. 30 min. and longitude 1 deg. 30 min. Weſt from London, being the city of Coventry. The firſt is on the 11th of May, 1724, the ſecond on July 14, 1748, calculated from Mr. *Street*'s *Aſtronomia Carolina*.

May 11, 1724, in the evening.	h.	m.	s.		h.	m.	s.
				14 July, 1748, m.			
The apparent time of the true ☌	5	17	3		11	16	38
The interval of true and viſible ☌	1	17	13	ſub.	0	39	14
The viſible ☌ — — —	6	34	16		10	37	24
Interval of viſ. ☌ and greateſt obſ.	0	0	16	ad.	0	0	54
The beginning — — —	5	38	9		9	8	12
The middle — — —	6	34	0		10	38	18
The end — — — —	7	26	25		12	12	30
The whole duration — —	1	48	16		3	14	18
Digits eclipſed — — So.	11	31	40	No.	10	16	13
Latitude of ☽ at beginning 1′	45″	S. D.		7′	18″	N. D.	
Latitude of ☽ at ending 2	11	S. D.		3	13	S. D.	

1724 

1748 

On February 18, 1737, happens a great eclipſe, but leſs than either of theſe two, being eclipſed digits 10 d. 5 m. The middle at 46 min. after 3 in the afternoon.

Tho' the induſtry of the ancients was very great, and the improvements of the latter days very conſiderable, yet was there one thing ſtill reſerv'd for the glory of this age, and the honour of the Engliſh nation, the grand ſecret of the whole machine; which now it is diſcover'd, proves to be (like the other contrivances of infinite wiſdom) ſimple and natural, depending upon the moſt known and moſt common property of matter, namely, gravity. From this the incomparable Sir *Iſaac Newton* has demonſtrated the theories of all the bodies of the ſolar ſyſtem, of all the primary planets, and their ſatellites, and among others, the moon, which ſeem'd moſt averſe to numbers, and the comets alſo, whoſe revolutions ſpend more than 2000 years about the ſun. A wonderful diſcovery! ſcarce ever to be hoped for by the boldeſt thinker.

Obſer-

Obſervations on the great Eclipſes.

The great ſolar eclipſe on the 22d of april laſt year, being by ſo many hands calculated, and there appearing ſo great a difference in the time of the eclipſe's happening, amongſt thoſe calculations; aud ſeeing each one ſo fond of his tables, or of thoſe he uſes, thereby to leſſen the eſteem, if poſſible, ingenious men bear to the Caroline tables; I have endeavoured to get what obſervations of that eclipſe I could, from ſeveral ingenious men, to prove which tables ſolved this phænomenon exacteſt. And foraſmuch as the calculation in the ladies' diary laſt year was for London, tho' by miſtake ſaid to be for Coventry, I have taken the pains to calculate that famous eclipſe again, and all along to compare it with what others have done, and do aſſure you, the reſult in the next ſide is the true calculation from the ſecond edition of *Street*'s tables. And that many others who calculated the ſame by thoſe tables, have not come within 8, 10, or 12 min. of the true time, is occaſioned, as I conceive, by miſtaking that author as to the abſolute equation of time, in page 83, making it about 3′ 15″ inſtead of 16′ 25″; differing above 13′ in that particular. Nor do I find any who have calculated by Mr. *John Wing*'s *Scientia Stellarum*, come near to obſervation unleſs himſelf, which, and that he did from Mr. *Shakerley*'s tables, are the two beſt I have met with, except the great Dr. *Halley*'s, and the indefatigable M. *Flamſtead*'s.

But what is more obſervable, ſcarce any one of them make it total, tho' calculated for near the path of the moon's center, or come near the true digits eclipſed, beſides thoſe from the Caroline tables; for my part I could never find it otherwiſe than total, even in London.

And becauſe nothing but good obſervation can help us to improve our future calculations, I have ſubjoin'd ſome as I receiv'd them, the 4th, 5th, 7th, 9th, 10th, 11th, and 12th, were communicated to me by my worthy friend the Rev. Mr. *Wright*, of Crew, in Cheſhire, whoſe accurate obſervations and ſkill in the jovial ſtronomy will (I doubt not) much advance it. The firſt was ſent me by my ingenious countryman Mr. *John Edens*, from Teneriffe, one of the Canary iſlands, taken on board, in the latitude 34° 20′ N. longitude 15° 20′ weſt from London. And laſtly, becauſe the eclipſe of the moon the 31ſt of october, 1715, by miſtake of the printer, had its type revers'd, I have again inſerted a new calculation from *Aſtronomia Carolina*.

Obſer-

Observations.	Begin. h. m.	Immer. h. m.	Emerf. h. m.	End h. m.
Canaries, by Mr. Edens	6 49	digits	ecl. 9	8 47
Dublin	7 47			9 51
Exeter, by Mr. Richards		8 52	8 56	
Chefter, by Mr. Ward	7 57$\frac{3}{4}$			10 6$\frac{1}{2}$
Crew, in Chefhire, by the Rev. Mr. Wright	7 59	9 2$\frac{1}{8}$	9 4	10 9
Worcefter		8 58$\frac{3}{4}$	9 2$\frac{1}{4}$	10 9$\frac{1}{2}$
Oxon		9 4$\frac{1}{2}$	9 8	10 14$\frac{1}{2}$
London	8 6$\frac{1}{4}$	9 9$\frac{1}{4}$	9 12$\frac{3}{4}$	10 20$\frac{1}{4}$
Wanfteed, Effex, Mr Pounds	8 6$\frac{1}{2}$	9 9$\frac{1}{2}$	9 12$\frac{3}{4}$	10 20$\frac{1}{2}$
Upminfter, by Mr. Derham	8 7$\frac{3}{4}$	9 11	9 14	10 21$\frac{1}{2}$
Ladfdown, in Kent, by the Rev. Mr. Thornton	8 7$\frac{3}{4}$	9 10$\frac{1}{2}$	9 13$\frac{1}{2}$	10 22
Feverfham, by Mr. Gray	8 9	9 13$\frac{1}{2}$	9 14$\frac{1}{2}$	10 24$\frac{3}{4}$
Lydd, by Mr. Hawney	8 9	not	total	10 23

The calculation of the fun's eclipfe, the 22d of april laft.

	h. m. s.	
The apparent time of true ☌	9 26 21	At Coventry, by *Aftronomia Carolina*, in the morning.
The vifible ☌ at — —	9 5 19	
The beginning — —	8 1 40	
The end — — —	10 15 49	
The whole duration —	2 14 8	
The digits eclipfed 12° 8′.		

The moon's eclipfe on the 31ft of october next, 1715, at London, happens the beginning 55 min. paft 2 in the morning; greateft obfcuration is at 15 min. paft 4, the end 35 min. after 5, the whole duration 2 ho. 39 min. and digits eclipfed 7° 56′.

In this year, 1716, on the 11th day of april, the fun will be eclipfed about two in the morning, and therefore not vifible; and on october the 4th invifible: of which eclipfes, had I room to infert the calculations, they would be ufelefs, excepting to the countries where vifible.

Paradoxes

Paradoxes to be anſwer'd next year, from an ingenious author.

Par. 1. There is a conſiderable number of places lying within the torrid zone, in any of which, if a certain kind of ſun-dial be duly erected, the ſhadow will go back ſeveral degrees upon the ſame, at a certain time of the year, and that twice every day for the ſpace of divers weeks; yet no ways derogating from that miraculous returning of the ſhadow upon the dial of Ahaz, in the days of king Hezekiah.

Par. 2. There are two diſtinct places of the earth lying under the ſame meridian, whoſe difference of latitude is 60 degrees compleatly, and yet the true diſtance between thoſe two places doth not really ſurpaſs 60 Italian miles.

Par. 3. There is a certain noted part of the earth, where the ſun and moon [ipſo tempore plenilunii] may both happen to riſe at the ſame inſtant of time, and on the ſame point of the compaſs.

Par. 4, *by* Heſychia.

I have 12 times ſeen the biſſextile, pray tell how that can be?
Since 12 times 4 make 48, and I'm but forty-three.

New Queſtions.

I. *Queſtion* 47, *by Mr.* John Edens, *of Teneriffe, one of the Canary iſlands.*

A little cloſe that lies in mooriſh ground,
Is by the following ſides encompaſs'd round;
A drain muſt be exactly three foot wide,
And into equal parts the cloſe divide;
The length of which I very fain would know:
But here obſerve, it muſt be order'd ſo,
That as little of the ſurface of the plain
May be broke up as poſſibly you can.
Juſt twenty chains the longeſt ſide contains,
The next when meaſur'd is juſt fifteen chains:
The leaſt ſide then in chains juſt ſix you'll ſee,
To prove your ſkill, you muſt explain to me
The juſt content each equal part muſt be.
That is, when from the whole you've took the drain,
I'd know how much o'th' land doth then remain.

II. *Queſtion*

II. *Question* 48, *by Mr.* Maſſey.

A wealthy knight in Lincolnſhire reſides,
Whoſe fields are waſh'd by the redundant tides
Of Wytham's chryſtal ſtream: his chiefeſt care,
Pomona like, is how to bleſs the year
With fruitful products, from the teeming tree:
For none more vers'd in ruſtick cult than he.
Oblong in form, extended from his houſe,
He did a cloſure for his garden choſe,
With choſen walnut plants he ſet it round,
At once to ſhade his walks and load the ground
Succeeding ſummers with prolific heat
Manur'd the infant trees, and made them great,
That they expand their tow'ring heads in air,
And ſtore of barricaded kernels bear:
September laſt the knight employ'd his man
To get the nuts, and bring the kernels in.
The man returns, and with myſterious phraſe,
Premeditated, to his maſter ſays,
Sir, your commands I willingly obey'd,
And as I wrought, this obſervation made,
On ev'ry tree ſo many boughs are found
As there are trees in all your garden round:
Nine of theſe trees as many walnuts bear
As upon all the trees there branches are:
If that you multiply the ſum by three,
You in the product all your nuts may ſee. (2187)
What, Sir, from this account I humbly crave,
Is that you tell how many trees you have.
The knight, unſkill'd in ſuch conceits as thoſe,
Took up the nuts, and ſmiling off he goes:
But turning ſhort again, ſays, Hark you Nat,
Send Mr. ———'s correſpondents that.

III. *Question* 49, *by Mr.* Hawney.

Come, artiſts, who to figures are inclin'd,
And try your ſkill four numbers for to find:
Which in progreſſion arithmetic are;
Whoſe common difference four does declare.
If theſe four numbers you ſhall multiply
Into one another continually,
The product thence ariſing you will ſee
The ſame as in the margin placed be. (176985)
Pray then don't fail in anſwering my requeſt,
For till they out are found, I cannot reſt.

IV. *Question*

IV. *Question* 50, *by* Philomathes.

That noble lady, ſtil'd the queen of hearts,
To the ingenious a query ſtarts,
Her ſtandiſh weigh'd on earth two pounds in troy,
But on the caſtle's top, juſt ſeven miles high,
She found its weight did there not prove the ſame:
Now ſhe would know what was its loſs or gain.

V. *Question* 51, *by* Tho. Fletcher.

Show me how to find out ſuch numbers three,
That when ſubtracted ev'ry one ſhall be,
From the cube of their ſum, there may remain
Three cubes: for I ſhall ne'er this problem gain.

VI. *Question* 52, *by Mr.* Tho. Pointin.

In ancient times, 'twas in the days of yore,
When malt was taxed, there was none before:
A malſter met a gauger on the way,
And in their conference he thus did ſay:
I have a ciſtern that's exactly ſquare;
The length, breadth, and depth, all three equal are.
Another too I have o'th' ſame quality,
But leſs in each part inches forty-three:
What both will hold, you in the margin ſee. (119·998 *buſh.*)
What hold they each? and their dimenſions?
Tell by your ſkill, and your inventions;
Or put in ladies' diary your intentions.

The Prize Question.

By Galilæo's heaven's high-climbing ſcale
Four * moons we ſee, to travel by and ſail
This earthly globe about. Now I would know
How th' optic tube theſe jovial moons does ſhow.
Which viſible: how † ſituate they'll appear,
‡ The ſeventh of october at ten this year.

* Jupiter's ſatellites. † In reſpect to the eaſt or weſt ſide of ♃.
‡ Anno. 1716, oct. 7 day, 10 h. P. M.

Anſwers

1717.

Anſwers to the Paradoxes propoſed laſt year.

TO *par.* 1. Anna Philomathes *ſays*, Any where in the torrid zone where the lat. is leſs than the declination of the ſun, and both towards the ſame pole, the ſun comes twice to the ſame point of compaſs both forenoon and afternoon, and an equinoctial ſun-dial placed horizontally, the ſhadow of the gnomon ſhall go back, plus minus, twice every day. But becauſe the par. mentions a certain kind of dial, I ſuppoſe, it may be thus anſwer'd, by a plain equinoctial dial deſcribed on both ſides of an horizontal plain with two gnomons, and near the tropic when the lat. and declin. are equal, before the ſun comes to the mathematical horizon in the morning he will ſhine on the lower ſide of the plain, and the ſhadow of the gnomon will run weſtward, *ad infinitum*, and preſently after 6 o'clock as he ſhines on the upper plain the ſhadow runs eaſtward till noon, and thence to 6 even. at which time the ſhadow on the lower plain will begin and run weſtward till ſun-ſet. There may by concave and convex, and reflex dials, be other ways of ſolving this.

Par. 2. The two places are not meant on the ſuperficies of the earth, as you may perceive by the word [of] (and not upon) ſo the places will be ſo near the center of the earth, as 2 lines ſuppoſed to come, one from (o) lat. the other from 60 lat. and to meet in the center, may approach within the diſtance of 60 Italian miles. *A. Philom. J. Pearce*, *J. Wylde*, and *Ri. Hall*, anſwer'd this.

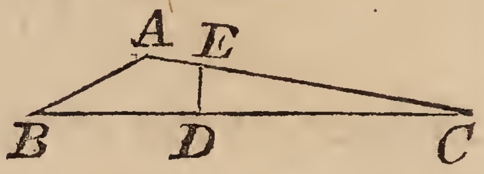
Par. 3. Under the north pole, the ſun and full moon both decreaſing in ſouth declination and lat. will riſe in the equinoctial points at the ſame moment, and under the north pole there is no other point of compaſs than ſouth. Anſwered by *A. Philom. R. Hall.*

Par. 4. Anna Philomathes *anſwers thus*, If a perſon be born on 25 feb. and travel weſtwards the globe about, he may ſee 12 biſſextile years before he be compleatly 44 years of age, if he be born in a biſſextile year. Mr. *Moyle*, *R. Hall*, *Ob. Flower*, and *J. Pearce*, anſwered this paradox.

Solutions to the laſt year's queſtions.

I. *The 47th queſtion anſwer'd.*

AB is 6 chains }
CA 15 chains } per queſt.
CB 20 chains }



The content is eaſily found to be 2 acres, 3 roods, 17 perch. and 45280 parts of a perch. The drain will cut off an iſoſceles triangle, whoſe two legs will be equal, repreſented by EC, CD. By the doctrine of fluxions, theſe two theorems for finding CD and DE will come out,

$$CD = \sqrt{\frac{ab}{2}} = 269\cdot4435 \text{ yards, and}$$

$$DE = \sqrt{\frac{2ab + c^2 - a^2 - b^2}{2}} = 51\cdot59457 \text{ yards.}$$

Now 13837·97 yards the whole area — 51·59457 = 13786 ·37543 ſquare yards after the drain is made.*

The

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* I. QUESTION 47 *ſolved.*

By theorem 7 of *Simpſon* on *The Maxima and Minima of Geometrical Quantities*, the required drain DE will cut off an iſoſceles triangle DCE; and ſince it muſt cut off half the whole (or the middle of the drain, repreſented by DE, is ſuppoſed to cut off half the whole), and triangles which have one angle common being as the rectangles of their ſides about the common angle, we ſhall have as $2 : 1 :: AC \times CB = 15 \times 20 : \frac{AC \times CB}{2} = 150 = EC \times CD = EC^2$; and hence $EC = CD = \sqrt{150} = 12\cdot2474487$ chains.

Now, by cor. 1 page 65 Menſuration, the triangle ABC is equal $\frac{1}{4}\sqrt{\overline{BC + CA}|^2 - AB^2 \times AB^2 - \overline{BC - CA}|^2} = \frac{1}{4}\sqrt{35^2 - 6^2 \times 6^2 - 5^2} = \frac{1}{4}\sqrt{41 \times 39 \times 11} = 28\cdot590875$ ſquare chains $= 13837\cdot9835$ ſquare yards.

And, by the ſame, the triangle DCE is $=$ $\frac{1}{4}\sqrt{\overline{DC + CE}|^2 - DE^2 \times DE^2} = \frac{1}{4}\sqrt{4CD^2 - DE^2 \times DE^2}$ = (by writing $2AC \times CB$ for its equal $4CD^2$) $\frac{1}{4}\sqrt{2AC \times CB - DE^2 \times DE^2}$.

But, by the queſtion, this latter triangle is equal to half the former; wherefore

$DE^2 \times$

II. *The 48th question answered by Mr.* Dod.

The lovely landskip, owing to the art
Of modern cult, improv'd in ev'ry part,
I view'd, and with unspeakable delight
Beheld the vernal walks; charm'd with the sight
Of seven and twenty walnut trees around,
Fertile, affording shade to th' walking ground,
And nuts, delicious fruit! might I aspire,
And once my wish obtain, I should desire
My habitation near the pleasing scene
That calms our ruffled thoughts, and makes us all serene.

A. Naughley,

$DE^2 \times \overline{2AC \times CB - DE^2} =$
$$\frac{AB^2 - \overline{BC - CA}|^2}{2} \times \frac{\overline{BC + CA}|^2 - AB^2}{2}.$$

But $\frac{\overline{BC + CA}|^2 - AB^2}{2} = 2AC \times CB - \frac{AB^2 - \overline{BC - AC}|^2}{2}$; which being written for it in the last equation above, we have $DE^2 \times \overline{2AC \times CB - DE^2} =$
$$\frac{AB^2 - \overline{BC - CA}|^2}{2} \times \overline{2AC \times CB - \frac{AB^2 - \overline{BC - AC}|^2}{2}}.$$

From this equation it is evident that

DE^2 is $= \frac{AB^2 - \overline{BC - CA}|^2}{2}$, and hence, as in the orig. solution,

$$DE = \sqrt{\frac{AB^2 - \overline{BC - CA}|^2}{2}} = \sqrt{\frac{6^2 - 5^2}{2}} = \sqrt{\frac{11}{2}} =$$

$\frac{1}{2}\sqrt{22} = 2{\cdot}34520788$ chains $= 51{\cdot}59457336$ yards $=$ the length of the drain, or $=$ its area since its breadth is one yard.——*(And this is a very curious and remarkable theorem.)*

By subtracting this from the whole area, we have 13786·389 square yards for the content remaining.

OTHERWISE.

The above solution supposes the drain to be a parallelogram, and that the middle line of it, or the line bisecting its breadth, divides the whole field into two equal parts: but, strictly and mathematical, that is not the case; for, by the question, the parts on each side of the drain must be equal, and then the said middle line of the drain will divide the figure into unequal parts; as will thus appear.

A. Naughley, in conclusion of an answer in verse, shews this algebraical solution: Let a be $=$ to number of trees, then aa will be the number of all the branches, and $aa \times 3 = 2187$ by the question. Therefore by division and evolution,

$$a = \sqrt{\frac{2187}{3}} = 27 \text{ the number sought.*}$$

III. *The 49th question answered by Mr.* M. Moyle.

Sir, fifteen, nineteen, twenty-three,
And twenty-seven your numbers be.

The same answered by Hesychia.

Fifteen and twenty-seven do, as it seems,
To the four numbers give the two extreams.

If the common difference be d, and the first number sought be equal to a, then $a \times \overline{a+d} \times \overline{a+2d} \times \overline{a+3d} = a^4 + 6da^3 + 11d^2a^2 + 6d^3a = 176985$ per quest. Now by

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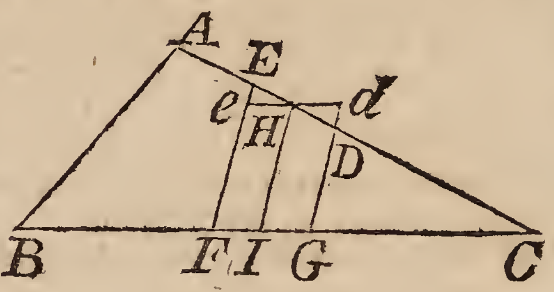
Let $DEFG$ represent the ditch, and HI the middle line. Through H draw de parallel to BC and meeting DG, EF in d and e: Then will be formed the two little equal isosceles triangles dHD, eHE, which will be both constant and given, because the angle C and the breadth of the ditch are so; and, since the parallelograms eI, HG are equal, as also the trapezium AF and triangle CDG by the question, it is evident that HI must be drawn cutting off the isosceles triangle $CHI =$ to $\frac{1}{2}$ the $\triangle ABC - 2$ the $\triangle eHE =$ a given area; to do which needs no pointing out here.



The calculation from hence would bring out the lines a little different from those above.

* II. QUESTION 48 *otherwise solved.*

There is one condition too many contained in this question, and it is accordingly omitted in the original solution above. If that condition be used; making x the number of trees, then $x^2 =$ the number of branches; hence $3x^2$ will denote the number of nuts, and $9 : x^2 :: x : \frac{x^3}{9}$ which will also denote the number of nuts; wherefore $3x^2 = \frac{x^3}{9}$, and $x = 27$.

by converging ſeries, the value of (a) will be found $= 15$ juſt. Therefore $a + d = 19$, $a + 2d = 23$, and $a + 3d = 27$; but $15 \times 19 \times 23 \times 27 = 176985$ as required.*

IV. *The 50th queſtion anſwered by Mr.* Fr. Walker.

That noble lady's ſtandiſh that weigh'd 2 pounds in troy, 47 grains did want when it was ſeven miles high.†

R. Beales. Xantippe, Chr. Maſon, and Mr. *Ronkeſly*, anſwered this philoſophical queſtion, 47 or 48 grains.

V. *The 51ſt queſtion anſwered by* Rob. Beales *and Mr.* Berriſſe, *and no other.*

For thoſe cube numbers 3, ſo nicely to be
That when every one is ſubtracted,
From the cube of their ſum, and yet to remain
Three cubes; has me almoſt diſtracted.

Thus $\frac{494424}{2352637}$, $\frac{472696}{2352637}$, and $\frac{448000}{2352637}$: Which taken ſeverally from $\frac{512000}{2352637}$ the cube of their ſum, leaves theſe

3 cubes,

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* III. QUESTION 49 *otherwiſe ſolved.*

Let $x + 2$ and $x - 2$ denote the two means, and $x + 6$ and $x - 6$ the two extreams; then, by the queſtion, $\overline{x + 2} \times \overline{x - 2} \times \overline{x + 6} \times \overline{x - 6} = \overline{x^2 - 4} \times \overline{x^2 - 36} = x^4 - 40x^2 + 144 = 176985$; or, completing the ſquare, $x^4 - 40x^2 + 400 = 177241$; the root of this is $x^2 - 20 = 421$, or $x^2 = 441$, and hence $x = 21$. Whence, the numbers are 15, 19, 23, 27.

† IV. QUESTION 50 *ſolved.*

Since the gravitation or weight of a body above the earth, is inverſely as the ſquare of its diſtance from the earth's center; if the earth's radius be ſuppoſed equal to 3993 miles, we ſhall have

$4000^2 : 3993^2 :: 2\,lb.$: the weight at 7 miles high; hence $4000^2 : 4000^2 - 3993^2 :: 2\,lb.$: the diminution,

Or $4000^2 : 7993 \times 7 :: 2\,lb. : \frac{7993 \times 7}{8000000} = \cdot 006993875\,lb. = 36\cdot 28472$ grains $=$ the weight loſt, or the decreaſe of gravity at that height.

3 cubes, $\frac{17576}{2352637}$, $\frac{39304}{2352637}$, and $\frac{64000}{2352637}$; whofe roots are $\frac{26}{133}$, $\frac{34}{133}$, and $\frac{40}{133}$.*

W. Beriffe.

VI. *The*

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* V. QUESTION 51 *folved.*

This is queftion 19 *Lib.* 5 of *Diophantus*, and is one of the moft difficult in his book; the numbers in anfwer are brought out by his commentator *Bachet*. Our countryman *Kerfey* and feveral others have folved this problem, and brought out other numbers anfwering the conditions. The various methods of folution are much the fame as to the effential principles; but we fhall give one nearly in fubftance according to *Schooten*, which feems to be as clear as any, who fays he learned it by reading *van Collen*'s letters, and who thought fo highly of his folution, that he fubfcribed it with, *Cujus rei foli Deo debetur gloria.*

By putting for the fum of the numbers required $4n$, whofe cube is $64n^3$; and $63n^3$, $56n^3$, and $37n^3$, for the numbers themfelves; each of which being taken from $64n^3$, there remain n^3, $8n^3$, and $27n^3$, three cube numbers as there ought. But alfo the fum of the numbers $156n^3$ ought to be $= 4n$; hence $39n^2 = 1$; and, to get n, the coefficient 39 ought to be a fquare.

To find numbers therefore, fo that the faid coefficient may be a fquare, let the fum of the numbers be 4, and two of the remaining cubes let be $\overline{n-1}|^3$, and $\overline{4-n}|^3$; each of thefe cubes being taken from 64 the cube of the fum, there remain $65 - 3n + 3n^2 - n^3$, and $48n - 12n^2 + n^3$ for two of the numbers; whofe fum is $65 + 45n - 9n^2$; to make the firft term of this a fquare by adding to it the third number, which muft alfo be the difference between the cube 64 and the 3d remaining cube, it appears that the faid 3d cube muft be 8; for then $64 - 8 = 56 =$ the 3d number; which added to the fum of the two former numbers, we have the fum of all the three $= 121 + 45n - 9n^2$. To make this a fquare, fuppofe it $= \overline{11+n}|^2 = 121 + 22n + n^2$; hence $n = \frac{23}{10}$; which fubftituted in the above values of the numbers, they become $\frac{61803}{1000}$, $\frac{59087}{1000}$, and 56; or rather thefe are proportional to the numbers fought.

But we have not yet provided for the equality between the fum of thefe numbers and the affumed fum; wherefore, to include that condition, let $4z$ be the fum of the numbers, and the numbers themfelves $\frac{61803}{1000}z^3$, $\frac{59087}{1000}z^3$, and $56z^3$; the fum of thefe is $\frac{17689}{100}z^3 = 4z$; hence $\frac{17689}{100}z^2 = 1$, and $z = \frac{20}{133}$. Which

fubftituted

* VI. *The 52d question answered by Mr.* Ed. Moore.

I've here agreed, in time of need,
At once to make two friends;
If gauger's eas'd, and malster's pleas'd,
I'll look for no amends.

The side of the biggest cistern 62·9999314825 inches.
The side of the lesser —— 19·9999314825 inches.
The biggest 116·2793 bushels. Lesser 3·7187 bushels.

A. Philomath.

Which may be found thus: Let 43 = difference of the sides, be $= d$, and the side of the greater $= a$, the side of the lesser shall be $= a - d$, and the sum of their cubes $= 2aaa - 3da^2 + 3d^2a - d^3 = 119\text{·}998$ bush. $\times 2150\text{·}42$, the solid inches in a Winchester bushel = 258046·099 inches, and tho value of a will be found = 63 proxime; consequently $a - d = 20$ inches. Then $\frac{63^3}{2150\text{·}42} = 116\text{·}278$ bush. and $\frac{20^3}{2150\text{·}42} = 3\text{·}720$ bushels, but their sum = 119·998 required.

A. Naughley, W. Whitworth, T. Cooch, R. Phillips, Xantippe, Ja. Wylde, John Smith of Hoppesford in Warwickshire, *J. Canning, W. Beriffe, J. Pearce, J. Symmonds, C. Mason, J. Stocks, W. Jachling, T. Court, W. Renkesley,* and *W. Crabb*, answered this question.

The

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substituted for it in the above assumed values of the numbers, we have $\frac{494424}{2352637}$, $\frac{472696}{2352637}$, and $\frac{448000}{2352637}$ for the 3 numb. required. And these answer all the conditions; for their sum is $\frac{1415120}{2352637} = \frac{8}{133} = 4z$; and the cube of this sum diminished by the three numbers themselves leave $\frac{17576}{2352637}$, $\frac{39304}{2352637}$, and $\frac{64000}{2352637}$; which are three cube numbers, whose roots are respectively $\frac{26}{133}$, $\frac{34}{133}$, and $\frac{40}{133}$.

* VI. QUESTION 52 *solved.*

This question may be otherwise more simply solved thus: Let z denote the half sum of the sides of the cubes, and $d = 21\frac{1}{2}$ the half difference; then will the sides themselves be $z + d$ and $z - d$; and the sum of their cubes is $2z^3 + 6d^2z = 119\text{·}998 \times 2150\text{·}42$ (the inches in a bushel), or $z^3 + 1386\frac{3}{4}z = 59\text{·}999 \times 2150\text{·}42$. Hence $z = 41\frac{1}{2}$ nearly; and consequently the sides = 63 and 20.

The Prize Question answered by Mr. T. Wright, *A. B. of Hart-Hall, Oxon. and who won the prize of* 10 *diaries.*

I'll tell exact how Jove's four moons appear,
On october the seventh, at ten this year. 1716.
As for the first but little can be said,
For he's at midnight rest within the shade.
The third, will from his master nigh be run
Its greatest distance towards the setting sun.
Likewise the second, will on the same side be,
Toward the third, from Jove two parts in three,
The fourth is nearest, in the east you'll see.*

To this difficult question I received but another true answer, viz. by Mr. *Ronkesley*, of Hodroyd, by Wakefield, in Com. Eborac. This part of astronomy is what but very few have the happiness of seeing; it requiring a telescope of a considerable length to reach the satellites of Jupiter.

Mr. Ronkesley's *answer.*

The first immerg'd, on's east the fourth you'll see,
The third and second, on the west will be.

An

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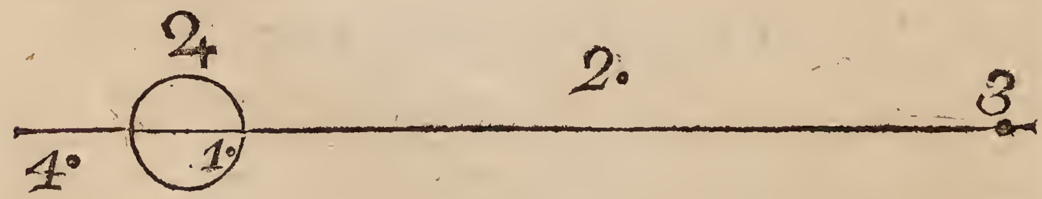
* PRIZE QUESTION *answered.*

It is evident that the difference between the geocentric place of Jupiter and the place of each of his satellites, for the given time, will give their distances from him in signs, degrees, &c. which may be turned into semidiameters of Jupiter. To do all which is fully taught in most books of astronomical tables. These calculations made for the proposed time will give the distances in semidiameters and tenths of Jupiter thus; viz. 1st satellite = 0·8 W. the 2d sat. = 7·9 W. the 3d. sat. = 15·0 W. and the 4th sat. = 2·2 E. Which being drawn from a scale of equal parts will appear thus



Where the configurations are adapted to the explanation given in the Nautical Almanac.

An account of Eclipſes to be publiſhed.

In this place I deſign'd to have given an account of ſome more of the viſible eclipſes of the ſun, as I did in my laſt, having them already calculated; but finding mine to agree ſo near to Dr. *Halley*'s, both of that great one paſt 22d april, 1715, and that yet to come in 1724, whoſe calculations I take to be grounded on the beſt hypotheſis yet diſcover'd, improved by the moſt accurate obſervations. I deſign to publiſh in a ſheet, engraved and printed, all the viſible eclipſes of the ſun that will happen before the year 1763, with their beginnings, middle, and endings, with exact types ſhewing the parts and digits eclipſed, their durations, and moon's latitude at the beginning, middle, and end of each, exactly calculated by *Aſtronomia Carolina*, for the meridian of Coventry, near the middle of England: of which timely notice will be given in the public papers. And here I am glad of an opportunity of doing juſtice to my induſtrious and indefatigable countryman Mr. *John Chattock*, late of Caſtle Bromwich, in Warwickſhire, by letting the world know I have all along compared mine with his calculations (done from *Wing*'s *Scientiæ Stellarum*) in manuſcript now in my hands, whoſe ability in theſe ſciences, the two excellent almanacs he publiſhed in 1708 and 1710 manifeſt. Whoever conſiders the care and pains that attend ſuch calculations, will readily excuſe ſome ſmall errors that poſſibly may eſcape; ſuch ſhall on notice be corrected in the enſuing diaries.

Here follow ſome obſervation of the moon's eclipſe paſt october 1715, and ſome of the immerſions and emerſions of Jupiter's ſatellites, whoſe uſes in finding longitude have long been approved, and others made of this kind will be gratefully received by the author from ſuch as are ſo much friends to this noble ſcience as to communicate them.

The moon's eclipſe 31ſt october, 1715, in the morning, I obſerved at Newnham, in Warwickſhire, lat. 52° 32′, long. 5 minutes in time after London, by a large quadrant and rectified pendulum; at the middle of this eclipſe a line drawn by the two extremities of the horns of the enlightened part of the moon, made an angle with the horizon towards the ſouth of 54 degrees, in which line 5 degrees diſtant above was Jupiter, and perpendicular over the moon 11 degrees diſtant the Pleiades; her altitude being then 27° 26′ the hour 4 h. 15 m. at 4 h. 45 m. 6 digits eclipſed; and moon's horns perpendicular at 5 h. 2 m. and dig. 3½; 15 minutes before the end the 2 horns made a north angle with the horizon of 84°: the eclipſe ended in the moon's limb diametrically op-

poſite

posite to the river Palus Mæotis, at the altitude of 16° 30′, and the hour 5 and 34 minutes.

At Crew, in Cheshire, it was observed, as well as the foggy air would permit, as follows.

	Crew h.	*Crew* m.	*Newnh.* h.	*Newnh.* m.
The beginning or penumbra — —	2	36	2	50
Ætna immerged at — — —	3	1¼		
Besbieus immerged at — — —	3	15½		
North part of Mæotis immerged — —	3	33½		
South part of Mæotis immerged — —	3	41		
The middle about 8 digits eclipsed —			4	15
Palus Mæotis emerged at — —	4	30		
The end at — — — —	5	24½	5	34
The whole duration — — —	2	48½	2	44

By the same person, and at the same place, was the emersions and immersions of Jupiter's satellites observed, as oft as the air would permit that season.

1715.	d.	h.	m.	s.		d.	h.	m.	s.
♃ 1 Sat. im. sep.	26	8	59	15	2 Sat. emer. dec.	29	5	4	10
2 Sat. im. oct.	8	8	55	30	1 Em. dec.	29	6	8	50
3 Sat. em. nov.	28	16	1	20	2 Sat. em. mar.	9	7	33	19
3 Sat. em. dec.	27	7	52	45	1 Sat. em. mar.	14	8	51	55

Apparent time.

By several observations, the times precede those of the calculations by the tables, by about 7 or 8 minutes. The regularity of which errors proves the observations the more accurate.

This year last past has produced several uncommon appearances in the air, as that unaccountable phænomenon on the 6th March, 1716, the halo's oft' seen, and heavenly bodies visible at noon, and according to this verse drew men's eyes upwards.

Os homini sublime dedit: cælumque tueri
Jussit, & erectos ad sidera tollere vultus. *Ovid.*

The eclipses of this year 1717.

There will happen in this year, 1717, four eclipses, two of each luminary: The first is one of the moon, on the 16th day of march, when the earth will interpose between the sun and moon, and hinder the sun's enlightning her, on her upper (or north) part above one half of her diameter appearing dark. The calculation I have deduced from the Caroline tables.

The

		h. m. s.
The mean oppoſition march 15th day, 1717 —		20 50 29
Interval of the mean and middle ☍ ſubtract —		6 4 43
The middle or equal time of the oppoſition —		14 45 46
At which time the ſun's place is in Aries —	d.	6 17 55
And the moon in Libra — — —		6 16 47
Difference from the oppoſition want — —		1 8
Hourly motion of ☉ 2′ 28″, of ☽ 33′ 14″ differ.		30 46
As 30′ 46″ to diff. 1′ 8″ :: 60 to the interval add		2 13
The middle time of the true ☍ 15° day —		14 47 58
At which time ☉ is in ♈ — —	ſig. 0	6 18 55
And the moon in Libra — — —	ſig. 6	6 18 46
The ☊ ſubtract by ☽'s place — —	ſig. 6	13 43 1
Remains the argument of latitude — —		7 24 15
☽'s lat. 39′ 6″ nor. aſcending reduction ſubt. —		1 41
Hourly motion of ☽ 33′ 55″, of ☉ 2′ 28″ diff.		31 27
As 31′ 27″ to red. 1′ 41″ :: 60′ to the ti. of riſ. ſub.		3 12
The equal time of the true ecliptic ☍ — —		14 44 47
Equation of time add — — — —		10
The apparent time of the true ☍ at London		14 54 47
The ☉'s horizontal parallax 15″, ☽'s 56′ 56″ ſum		57 11
Subtract 15′ 56″ ſemid. ☉ rems ſemid. ☉'s ſhad.		41 15
To which add ſemid. ☽ 15′ 24″ the ſum is —		56 39
Latitude of the ☽ ſubtract — — —		39 6
Remains the parts deficient — — —		17 33
As 15′ 24″ to 6 digits :: 17′ 33″ to the digits ecl.		6 50 0
Reduct. or interval of greateſt obſcuration add		6 22
To the appar. times gives the greateſt obſcur. at		15 1 9
As 31′ 27″ to 60′ :: min. of incidence 41′ to half duration* — — — —		1 18 13

Hence

* This eclipſe of march 15th, was obſerved as follows.

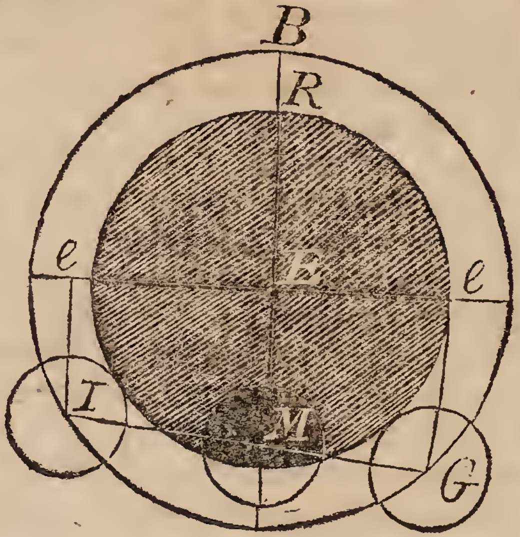
Places	Obſervers	Beginn. h. m. s.	End h. m. s.	Digits eclip.
Lima in Peru	D. Peter Peralta	8 4 8	11 19 55	
Cambridge, New England	Mr. Robie	9 about	11 42 30	
The Iſland of Virgin Gorda	Capt. Chandler		12 30 0	
St Coſma in South America	F. Bon. Suarez	10 2 21	12 45 40	$7\frac{3}{10}$
Paris — — —	Mr. Caſſini	13 55 0	16 38 25	$7\frac{1}{2}$
Paris — — —	Mr. de la Hire	13 54 0	16 38 10	$7\frac{1}{3}$

Hence the eclipſe march, 16°, 1717.
The beginning 42 min. 48 ſeconds paſt I. in the morning.
The middle 1 min. paſt III. in the morning.
The end 19 min. 14 ſeconds after IV. in the morning.

A type of the moon's eclipſe the 16th of march, at 3 in the morning.

		m.	s.
Semidia. of ſhad.	*E R*	41	15
Initial lat. of ☽	*e G*	41	37
Medial —	*E M*	39	6
Final lat. ☽ —	*e I*	33	59
Semidiam. of ☽	*R B*	15	24

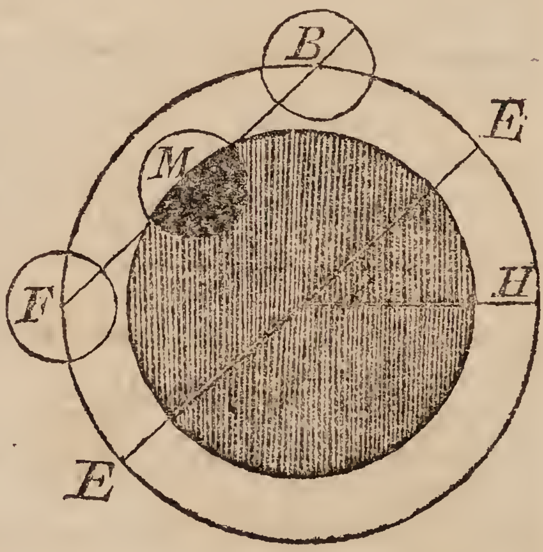
G the ☽ at begin. *M* at midd.
I at end, *eEe* the ecliptic.



The ſecond is of the ſun, 31ſt of march, at 19 minutes paſt 4 in the evening; but although the moon be but 70° 46′ from the ſouth node, and near 4° within the eclipſing bounds, yet her lat. being then 4°′ ſouth, and the ſun's declination about 8° 2′ north, hinders the moon's ſhade falling near us, and therefore called inviſible to any of the northern parts.

The third is of the moon on monday the 9° of ſeptember, at 6 in the evening, when 7 digits 26 minutes of the moon's diameter will be darkened on her lower or ſouth part of her diſk. So much as room will permit of the calculation follows.

Sept. 9°, 1717. Eve.		h.	m.	s.
The corr. eclip. ☋		6	13	20
Appar. time Lond.		6	4	40
Beginning aftern.		IV	46	58
Mid. vel max. obſ.		VI	11	3
End —	—	VII	35	8
Whole duration		II	48	10
Digits eclipſed		7	26	40
Moon's lat. at beg.	*E B*		40	25
At end, alſo nor. deſ.	*E E*		32	29



This figure ſhews exactly the appearance of this eclipſe; *B* ſhews the moon where it begins, *M* at the middle, and *E* at

at the end, *EE* is the ecliptic, *EMB* the moon's way, and *FH* is the horizontal line in the eclipse.*

The fourth is an eclipse of the sun on monday the 23d of september, at 9 minutes past 7 in the evening; but the moon's lat. being 1° 17′ north, and the sun's decl. 4° 40′ south, the shade would not fall near us, tho' the sun was not set.

Paradoxes to be answer'd next year.

1. There's a certain village in the south of Great Britain, to whose inhabitants the body of the sun is less visible about the winter solstice, than to those who reside upon the island of Iceland.

2. There's a certain place of the earth, of a considerable northern latitude, where, tho' the days and nights (even when shortest) do consist of several hours; yet in that place it is mid-day or noon every quarter of an hour.

3. There are divers places on the globe of the earth, where the sun and moon, yea, and all the planets, do actually rise and set according to their various motions; but never any of the fixed stars.

4. There is a certain city in the southern part of China, whose inhabitants (both male and female) do observe almost the same posture and gait in walking as we Europeans; and yet they frequently appear to strangers, as if they walked on their heads.

Twenty-four of those amazing paradoxes in *Gordon*'s *Geography* have been inserted in the ladies' diary; twenty of which are in it already, explain'd; so in time the whole forty-five will be solv'd.

A

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* The eclipse of Sept. 9 *P. M.* was observed thus,

Places	Observers	End		
London —	Royal Society —	7h.	27m.	
Paris — —	M. Cassini — —	7	34	50s.
Paris — —	M. de la Hire —	7	34	15
Paris — —	M. Miraldi —	7	35	30
Norimburg	M. Wurtzelbaur	8	10	45

On monday June 10th this year, Dr. Halley discovered a small telescopical Comet; whose place at 11 o'clock that evening was ♐ 17° 12′ with 4° 12′ south latitude.

A Philoſophical Queſtion, by A. Philomathes.

A golden ball ſhall weigh two pounds in troy,
Where from th' equator ten degrees does lie;
But at London, a diff'rent weight is found
Of that ſame ball: which diff'rence pray expound.

New Queſtions.

I. *Queſtion* 53, *by Mr.* Tho. Dod.

A fortunate merchant got riches good ſtore,
And had jewels ſo many, you'd ne'er deſire more:
But the way to ſecure them, he cover'd them over
With cloth for his buttons, ſo none cou'd diſcover
The worth of his coat, he had on his back;
Which above a piſtole you'd ha' ſworn ne'er wou'd take:
So by this means he carry'd it ſafe; and 'twas ſold
After ſuch an odd way as you never heard told.
Some jewellers then that were ready to doat
On the buttons, did join for to buy the rich coat;
And agreed in proportion geometrical
Thus to pay for the coat by the buttons, which all
Were no more than ſixteen; and a penny was paid
For the firſt button only: the laſt, as they ſaid,
To this number of pence*, ſir, you ſee, did amount:
So they aſk'd me to try with my pen, and to count
What the ſum was in pounds, ſhillings, pence, which it coſt;
But by trying, I found myſelf preſently loſt:
For I wanted to know how the ratio increas'd;
Which, if you will ſhew, I'll be very much pleas'd:
Or, I'll thank you to tell me but what the coat coſt,
In a line to your ſervant, ſir, by the next poſt.

* 14348907 pence.

II. *Queſtion* 54, *by Mr.* Rob. Beales, *of Lynn.*

If London from Norwich be miles ninety-nine,
And from thoſe two cities two footmen deſign,
The firſt to go three miles the firſt day from London,
The ſecond day five miles; next ſev'n, and ſo on
Towards Norwich, from whence the ſecond one muſt
The ſame time go for London to meet with the firſt;
Whoſe firſt day's journey exactly is fix'd
To be of the days they'll meet on, the ſixth:
His ſecond day's journey does alſo agree
To exceed the firſt in miles juſt by three,
So each day's journey in exceſs muſt be.

From

From this I would know, how you'll diſcover
The days they'll be going till they meet one another:
And how many miles then each will have gone,
Is what I requeſt you'll be pleas'd to get done.

III. *Queſtion 55, by* Xantippe, *of Helmſley, Yorkſhire.*

Once, as I walk'd upon the banks of Rye,
To ſee the purling ſtreams glide gently by,
And hear the pretty birds to chirp and ſing,
Making the groves with melody to ring;
I in the meads three beauteous nymphs did ſpy,
Who there for pleaſure came as well as I;
And unto me their ſteps they did direct;
Saluting me with moſt benign reſpect:
Saying, 'Well met: we've bus'neſs to impart,
'Which we cannot decide without your art.
'Our grannum's dead, and left a legacy,
'Which is to be divided 'mongſt us three.
'In pounds it is two hundred twenty-nine,
'And a good mark, it being ſterling coin.'
Then ſpake the eldeſt of the lovely three,
'I'll tell you how it muſt divided be;
'Likewiſe our names I unto you will tell;
'Me they call Moll, my ſiſters Anne and Nell:
'As oft as I five, and five-ninths do take,
'Four and three ſev'nths Anne takes, her part to make;
'As oft as Anne four and one-ninth does tell,
'Three and two-thirds muſt be took up by Nell.

IV. *Queſtion 56, by Mr.* W. Beriſſe, *of St. Ives.*

Ingenious algebraiſt, I fain wou'd know
An anſwer to this queſtion here below.
A friend of mine aſk'd me the other day,
A little ſpot of land for to ſurvey,
That lay in form of a tripezia.
I ſoon comply'd with his requeſt, and found
Three acres, wanting ſixteen poles, of ground;
The ſides in chains here you may plainly ſee;
The firſt was four, the ſecond juſt twice three;
Seven was the third; and for the fourth thus reckon'd,
It being juſt the half of firſt and ſecond.
No parallel ſides to you I muſt declare,
Nor angle right will be admitted here.
Ye ſons of art, I do requeſt you all
To give a cannon algebraical,
To find the length of the diagonal.

But one word more, left you be overseen;
It is the longest which I here do mean.

V. *Question* 57, *by* J. Symmons.

Dick Dibble is almost out of his senses,
And begs me to be his amanuensis
To th' ladies, that in their next diary
They'll please to answer a gard'ner's query:
For orders lately from his master came,
That puzzle poor Dibble: altho' the same
To many others wou'd plain enough speak:
Dick says, the most on't is mere heathen greek.
A workman from him some directions must take,
About some dials that he is to make:
But he or the t'other can nothing effect,
Except the fair ladies, in pity, direct.
His master's first words to Dibble confound;
Degrees fifty-two, fifty minutes is found
The latitude, in the midst of the ground.
There on the plane a streight staff you must fix
At right angles; on whose top, or apex,
Fourscore inches high, a small knob or ball.
March the second, mark how the shadow doth fall
From the foot of the staff, just on a south sun.
The 11th of june the same must be done,
When the sun is due west. These lengths being got,
Are half the diameters of the grass plot:
Which is an ellipsis or oval to be,
The area, in inches, divide into three;
Two-thirds of that sum the mason must take,
For a stone step that he is to make
Of elliptical form, and five inches deep:
Whose length and breadth equidistant must keep
From the verge o'th' other great one of grass;
On the step four lions couchant of brass,
Supporting a cube: which serves as a base
To a dodecaedron; and that bears a sphere.
These solid bodies this proportion must bear
Of six, three, and one, exactly (or near)
The area's third, these bodies must have.
Now ladies, Richard most humbly does crave,
What the sides of the cube and dodecaedron are?
And what is the axis also of the sphere?

VI. *Queſtion 58, by the Lady* Mer. Heyſhot.

Two ſons I have, comfort to me impart,
And when in view, they do rejoice my heart.
How old they be, is all I fain would know,
Suppoſing true what here I ſtate below.
The age of one being ſquar'd, if from 't you take
The younger's age, the reſidue will make
As this (425): then ſquare the younger's age,
From which deduct the elder's, and I'll engage,
The reſidue two hundred thirty-five you'll find.
Their age to tell, pray ladies, be ſo kind.
This I forgot: if to fifteen ſquar'd you add
A hundred, their ages' product may be had.

The Prize Queſtion, of 10 *diaries to the anſwerer.*

Upon a horizontal plane there ſtood
A handſome tetrahedron, very good;
I lik'd it well, and well the ſame I view'd,
And found five ſolid feet its craſſitude:
Beſide it ſtood a priſm triangular,
Whoſe height and ſide at baſe both equal are;
Its content thirty-ſix ale gallons good,
But being bottomleſs, while ſo it ſtood,
To put in liquor none there venture wou'd.
At laſt I fix'd the priſma very tight
Upon the tetrahedron that was by't;
This done, ſaid I, ſee by this piece of ſkill,
With ale or beer, the veſſel ye may fill.
I aſk the gaugers now, how much they think
There's in the caſk, of ale or other drink?
In anſwer to the query, pray unfold,
How much at once the caſk ſo plac'd can hold:
And alſo tell, how much th' elevation
O'th' priſma is above its former ſtation:
But to prevent miſtakes i'th' gauging part,
Know, that a pyramid well wrought by art
Triangular, the mouth cloſe down did ſtop,
Whoſe point juſt touch'd the tetrahedron's top.
I've ſaid enough, by which the artiſts know
The anſwer of the query how to ſhow.

1718.

Anſwers to the Paradoxes propoſed laſt year.

Par. 1. MR. *R. Budgen* ſays the village lies under a high mountain near Lewis, in Suſſex; that about the winter ſolſtice the ſun is but a very ſmall ſpace of time viſible to the inhabitants.

Par. 2. Under the north pole.

Par. 3. Under the poles the planets by their motions get north or ſouth declination, conſequently riſe and ſet with relation to thoſe two places: but the fix'd ſtars keeping an exact diſtance from the pole, may be ſaid *never* to riſe, or ſet, tho' their motion on the poles of the ecliptic may be thought ſome ſmall objection to this paradox.

Par. 4. In China, (or any other place) where the inhabitants ſtand near the ſea, ſtrangers looking in it muſt ſee them, as tho' their heads were downward by the reflected viſion.

An anſwer to the philoſophical queſtion.

Mr. *John Wilkinſon* ſays, the proportion of gravity betwixt the equator and poles, is as 500 to 501, by the incomparable Sir *Iſaac Newton*; and the increaſe near as the ſquare of the right ſine of the latitude; and that the ball would weigh more at London than at 10 deg. lat. by 13 grains.

This is, I preſume, occaſioned from the earth's oblate figure, and the diminution of the centifrugal force.

Mr. *Doidge*, Mr. *White*, Mr. *Bleathman*, Mr. *E. Weaver*, and Mr. *R. Hall*, anſwer'd the 2d and 3d paradoxes.
Mr. *Whitworth* 2d, 3d, and 4th, Mr. *Langley* 2d, Mr. *Maſon* 3d, Mr. *Budgen* 1ſt and 3d, Mr. *Child* 2d and 4th.

Solutions

Solutions to the last year's questions.

I. *Question* 53 *answered by Mr.* J. Peirce.

$\sqrt[15]{14348907} = 3$ the ratio. Let p be = first term = 1, s = second term = 3, u = last = 14348907, and z = sum of all the terms. Now $z - u$ = sum of all the antecedents; $z - p$ = sum of all the consequents. Therefore $p : s :: z - u : z - p$; and by equality $pz - pp = sz - su$; by transposition, and division, $z = \frac{3u - 1}{2} = 21523360$ pence $= 89680\,l.\ 13\,s.\ 4\,d.$

* II. *Question* 54 *answered by* R. Hall.

Their journey went to six days,
  Before they met each other;
The Londoner he went so fast,
  Three miles out-strid the other. 51 and 48.

III. *Question*

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* II. QUESTION 54 *solved.*

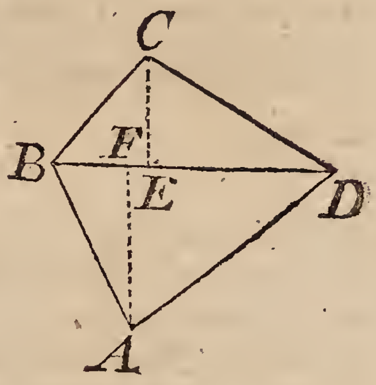
Putting x for the number of days they travelled, or the number of terms in each series, of which the two common differences are 2 and three; the corresponding first terms will be 3 and $\frac{1}{6}x$, the last terms $= \begin{cases} 2 \cdot \overline{x-1} + 3 = 2x + 1 \\ 3 \cdot \overline{x-1} + \frac{1}{6}x = 3\frac{1}{6}x - 3, \end{cases}$ the sums of each pair of extremes $= \begin{cases} 2x + 4 \\ 3\frac{1}{3}x - 3, \end{cases}$ and the sum of each series, or the miles each travelled $= \begin{cases} x^2 + 2x \\ \frac{5}{3}x^2 - \frac{3}{2}x. \end{cases}$

Then by taking the sum of these two sums, we have $\frac{8}{3}x^2 + \frac{1}{2}x = 99$; and hence $x = 6$ = the number of days, and $\left.\begin{matrix} x^2 + 2x = 48 \\ \frac{5}{3}x^2 - \frac{3}{2}x = 51 \end{matrix}\right\}$ = the miles each travelled.

* III. *Question* 55 *answered by Mr.* J. Simmons.

91 *l.*	11 *s.*	4 *d.*	$\frac{1673}{2842}$	Is the share for Molly,
72	19	10	$\frac{1593}{2842}$	Is what Nan ought to take,
65	2	0	$\frac{2058}{2842}$	Makes the part for Nelly,
229	13	4		If I've made no mistake.

IV. *Question* 56 *answered by Mr.* Ja. Peirce.



Let $BC = 4 = b$, $AD = 7 = g$,
$CD = 6 = c$, $AB = 5 = f$,
$CD + BC = 10 = e$, $AD + AB = 12 = h$,
$CD - BC = 2 = d$, $AD - AB = 2 = i$.

The area 2 a. 3 r. 24 per. = 29 sq. cha. $= a$. *Quere* diagonal $BD = y$.

(1). $y : e :: d : \frac{de}{y} = DE - EB$;

and $y : h :: i : \frac{hi}{y} = DF - FB$.

(2). $\frac{yy + de}{2y} = DE$, and $\frac{yy + hi}{2y} = DF$.

(3).

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* III. QUESTION 55 *solved.*

The numbers $5\frac{5}{9}$ and $4\frac{3}{7}$, or $\frac{50}{9}$ and $\frac{31}{7}$ are in proportion as 350 and 279; and the numbers $4\frac{1}{9}$ and $3\frac{2}{3}$, or $\frac{37}{9}$ and $\frac{11}{3}$ are to each other as 37 to 33. Now, $279 : 350 :: 37 : \frac{37 \times 350}{279}$; and hence the three shares must be in proportion as the three numbers $\frac{37 \times 350}{279}$, 37, and 33; or as 37×350, 37×279, and 33×279; that is, as the numbers 12950, 10323, and 9207; whose sum is 32480.

Whence, by proportion, we shall have as 32480 : 229 *l.* 13 *s.* 4 *d.*

$$:: \begin{cases} 12950 : 91\,l.\ 11\,s.\ 4\frac{294}{406}\,d. = \text{Moll's share,} \\ 10323 : 72 \quad 19 \quad 10\frac{233}{406} = \text{Ann's share,} \\ 9207 : 65 \quad 2 \quad 0\frac{279}{406} = \text{Nell's share.} \end{cases}$$

(3). $\sqrt{\dfrac{4c^2y^2 - y^4 - 2dey^2 - d^2e^2}{4y^2}} = CE$:

$\sqrt{\dfrac{4g^2y^2 - y^4 - 2hiy^2 - h^2i^2}{4y^2}} = AF$.

(4). These two last $\times$ by $\frac{1}{2}y$, and added together give the area.

(5). Then by extracting the square root of the denom. and multiplying a by 4, you'll have

$\sqrt{4c^2y^2 - y^4 - 2dcy^2 - d^2e^2} +$
$\sqrt{4g^4y^2 - y^4 - 2hiy^2 - h^2i^2} = 4a$.

(6). By squaring both sides of the last equation, and transferring the rational terms to one side, you'll have (after making $4c^2 - 2cd = k$, $-ddee = -l$; $4g^2 - 2hi = m$, $-hhii = -n$;) $2\sqrt{\overline{ky^2 - y^4 - l} \times \overline{my^2 - y^4 - n}} = 16aa - ky^2 - my^2 + 2y^4 + l + n$.

Let $16a^2 + l + n = p$, and $-ky^2 - my^2 = -qy^2$.

(7). By squaring both sides of this last (p and $-q$ rightly placed) you'll have $4kmy^4 + 4ly^4 + 4ny^4 - 4lmy^2 - 4kny^2 - 4my^6 - 4ky^6 + 4y^8 + 4ln = p^2 + 4py^4 + q^2y^4 - 2pqy^2 + 4y^8 - 4qy^6$.

(8). But $4y^8 = 4y^8$ is destroyed; also by supposition $m + k = q$. Therefore $-4my^6 - 4ky^6 = -4qy^6$, which will be destroyed. Lastly, by transposing the known quantities to one side, and the unknown to the other, you'll have $4kmy^4 + 4ly^4 + 4ny^4 - 4py^4 - q^2y^4 + 2pqy^2 - 4lmy^2 - 4kny^2 = p^2 - 4ln$.

Let $4km + 4l + 4n - 4p - qq = r$; $2pq - 4lm - 4kn = s$, and $p^2 - 4ln = t$. Then $ry^4 + sy^2 = t$.

From whence will arise this theorem,

$y = \sqrt{\sqrt{\dfrac{ss}{4rr} + \dfrac{t}{r}} - \dfrac{s}{2r}} = 7{\cdot}682$ chains, the longer diagonal; the other is $7{\cdot}554$ chains.*

V. *Question*

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* IV. QUESTION 56.

Constructions and other solutions of this question may be seen in *Simpson*'s Algebra and his Select Exercises.

* V. *Question* 57 *answered by* Ja. Peirce, Wm. Whitworth, Jos. Wilkinson, *and* Moses Bleathman.

Mar. 2. Sun's longitude 22° 56′ 34″ ♓. Declin. 2° 48′ 28″ S. The sun's meridian altitude, 34° 21′ 32″.

Length of the shade, 117·056 inches; which doubled, gives the conjugate diameter of the oval 234·112 inches.

June 11. Sun's longitude — — —	♋ 0°	55′	41″	
Declination north — — — —	23	29	48	
Sun's altitude east or west — — —	30	1	16	
Length of the shadow —	138·4 inches			
Doubled the transverse diameter	276·8			
The area of the oval — —	50916·0155			
$\frac{1}{3}$ Taken for the 3 solid bodies —	16972·0051			
$\frac{2}{3}$ For the step — — —	33944·0102			
Transverse diam. of step — —	116·716			
The conjugate diam. of the step	74·028			
The side of the cube — —	21·675			
Side of the dodecaedron — —	8·726			
Diameter of the globe — —	14·799			

VI. *Question*

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* V. QUESTION 57 *solved.*

The method of solving this question is thus:

By astronomical tables find the sun's place or longitude to the two given times; and the obliquity of the ecliptic or the greatest declination for the same: then, by spherics, it will be, as radius : sine long :: sine obliq. : sine of the present declinations. In the first case, the declin. taken from the colat. leaves the meridian altitude; and in the other, we shall have, by spherics, as s. lat. : s. obliq :: radius : s. altitude. These altitudes being thus computed, we shall suppose to be 34° 21′ 32″ and 30° 1′ 16″ as in the original solution above.

Then, by plain triangles, as 1 (rad.) : 80 (length of staff) :: cotang. alt. : length of the shade; consequently 160 × 1·4622874 (cotang. 34° 21′ 32″) = 234·034176 inches = the conjugate diameter, and 160 × 1·7305780 (cotang. 30° 1′ 16″) = 276·89248 = the transverse diameter; and hence the area of the green is 276·89248 × 234·034176 × ·78539 &c. = 50895·58. Then $\frac{1}{3}$ of this being a number expressing the sum of the contents of the three solids, which are in proportion to one another as 1, 3, and 6, whose sum is 10; we shall have, as 10 : $\frac{50895·58}{3}$

$$:: \left\{\begin{array}{l} 1 : 1696·519 = \text{the content of the sphere} \\ 3 : 5089·558 = \text{the content of the dodecaedron} \\ 6 : 10179·116 = \text{the content of the cube} \end{array}\right\}$$; and, by

mensu-

* VI. *Question* 58 *answered by* Moses Bleathman.

I see a fault, but can't devise,
Not for my life, in whom it lies:
Wheth'r in the author, or the printer,
Or else in me, the fault's amender.
If I am right, the eldest son
Had twenty-one years over-gone;
The other sixteen years I see:
But this does not with you agree.

Answer to the Prize Question.

Mr. *Char. Mason*, Mr. *Tho. Cary*, (who won the prize) Mrs. *Mary Nelson*, Mr. *John Cary*, Mr. *Peter Ward*, Mr. *Peirce*, Mr. *Witworth*, Mr. *Carrington*, Mr. *J. White*, Mr. *Bleathman*

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mensu. $\sqrt[3]{10179.116} = 21.6722 =$ the side of the cube,

$\sqrt[3]{\frac{5089.558}{7.66311896}} = 8.7248 =$ the side of the dodecaedron,

$\sqrt[3]{\frac{1696.518}{\frac{1}{6} \times 3.14159\&c.}} = 14.7975 =$ the diameter of the sphere.

Again, for the diameters of the inner ellipse, or stone step, whose solidity is $\frac{2}{3}$ of the area of the outer one, and the difference of its diameters $=$ $(276.89248 - 234.03418 =)$ 42.8583; let $x =$ half the sum of its diameters, then the diameters will be $x \pm 21.42915$ $\left(= \frac{42.8583}{2}\right)$; and their product $x^2 - 21.41915^2$ (per quest.) $= \overline{276.89248 \times 234.03418} \times \frac{2}{3} \times \frac{1}{5} = 8640.304$; hence $x = \sqrt{21.42915^2 + 8640.304} = 95.3914$, and $95.3914 \pm 21.4291 = 116.8205$ and $73.9623 =$ the diameters of the inner ellipse.

* VI. QUESTION 58 *solved.*

Putting x and y for the two ages, we have, per question, $x^2 - y = 425$, and $y^2 - x = 235$ (omitting the 3d condition as superfluous); hence $y^2 = 235 \times x = \overline{x^2 - 425}|^2$, or $x^4 - 850x^2 - x = -180390$; in which equation $x = 21$; and then $y = x^2 - 425 = 16$.

Bleathman, Mr. *Wilkinſon*, Mr. *Edmund Weaver*, Mr. *R. Hall*, Mr. *Joſ. Smith*, anſwered this queſtion as below.

	Inches.
The ſide of each triangle of the tetrahed	41·853
The perpendicular altitude — —	34·17283136
The ſide and altitude of the priſm — —	28·6209
Conſequently the ſide of the baſe of that Part of the tetra. which is within the priſm.	28·6209
Its perpendicular altitude — — —	23·3688
Its content in ale-gallons — — — —	9·79793
The perpendicular altitude of the pyramid	5·25204
Its content in ale-gallons — — — —	2·20203
The content of the two pyramids — —	11·99999
Content of the priſm when placed according to the import of the queſtion in ale-gall.	24·0000
The elevation of the priſm — — —	10·8039

Eclipſes

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* PRIZE QUESTION *ſolved.*

Since the two ends of the priſm are filled up by two pyramids whoſe vertexes meet within it, the height of the two together is juſt equal to the alt. of the priſm; and ſince a pyramid is $= \frac{1}{3}$ of a priſm of the ſame alt. and baſe, it is evident that $\frac{2}{3}$ of the priſm will be filled with liquor, that is, it will contain 24 gallons; which is one part of the demand. The other is to find the additional elevation of the priſm, which, being evidently = the difference between the altitude of the tetraedron and of the part of it which is let into the priſm, will be found thus.

By the Schol. page 403 Menſuration, $12\sqrt[3]{6 \times 5\sqrt{2}} =$ $12\sqrt[3]{30\sqrt{2}} = 41{\cdot}853$ inches = the ſide of the whole tetraedron; and by page 81 and 145, we ſhall have $\sqrt[3]{\frac{36 \times 282 \times 4}{\sqrt{3}}} =$ $6\sqrt[3]{\frac{188}{\sqrt{3}}} = 28{\cdot}62092$ = the ſide of the priſm = the ſide of the tetraedron which is within the priſm. And it is the difference of the altitudes of theſe two which is required. Now, from the demonſtration page 403 Menſuration, it appears that the ſide of a tetraedron is to its altitude, as 1 to $\sqrt{\frac{2}{3}}$; and ſince the difference between 41·85300 and 28·62092 the ſides of the two tetraedrons is 13·23208, we ſhall have $13{\cdot}23208\sqrt{\frac{2}{3}} = 10{\cdot}80394$ = the additional elevation required.

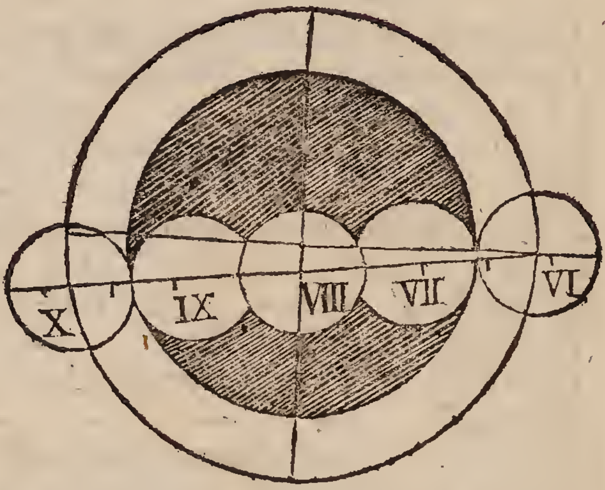
Eclipſe of the moon, 1718.

Once this year will the earth's ſhadow quite hide the body of the moon from our ſight, which will be on friday the 29th of auguſt, at 8 at night, being a total eclipſe of the moon. The calculation I have lately made, and compared with my former, from *Aſtronomia Car.*

		h.	m.	s.
The mean ☍ auguſt the 29th, evening		8	1	1
The mean anomaly of the earth	ſig 2	10	55	2
Of ☽	0	10	43	16
Longitude of the ſun	♍	16	34	4
Of ☽	♓	16	28	37
Difference from the oppoſition want			5	27
Hourly motion of ☉ 2′ 26″, of ☽ 30′ 7″ differ.			27	31
27′ 31″ to 5′ 27″ :: 60 to the interval, add			11	0
The middle or equal time		8	12	1
To which time the ſun's place is	♍	16	34	6
☽'s place	♓	16	34	44
Difference from the oppoſition paſt				38
Hourly motion of ☉ 2′ 26″, of ☽ 30′ 8″ differ.			27	42
As 27 42 to 38″ parts :: 60 to interval ſub.			1	23
Equal time of the true ☍ auguſt	29	8	10	38
Subtract ☊ from ☽ place reſts argum. laſt	6	0	50	33
Reduct. ſub. 12″ ☽'s latitude ſouth deſcend.			4	22
From hourly motion of ☽ 29′ 37″ ſub. ho. mot. ☉			2	26
Remains the hourly motion of ☽ á ☉			27	11
17′ 11″ to red. 12″ :: 60″ to time of red. add				23
Correct time of the true ecliptic oppoſition		8	11	1
Semidiameter ☉ 15′ 49″, ſemidiameter of ☾			14	20
Horizontal parallax ☉ 15″, ☽'s 53′ ſum			53	15
Semidiamet. ☉ ſubt. remains ſemid. ☉'s ſhad.			37	26
Semediamer ☽ 14′ 20″ add, ſum of ſemidi.			51	46
Latitude ☽ ſubtract, remains parts deficient			47	24
14′ 20″ : 6 dig. :: 47′ 24″ parts defic. to dig.		20	2	0
Interval of ecliptic ☍ and max. obſcur. add				44
Minutes of incidence and half tarriance			51	35
The time of half duration		1	53	51
Equation of time add			11	53
Apparent time of greateſt obſcuration		7	59	8
Difference of meridians ſubtract			6	0
Apparent time max. obſcuration at Coventry		7	56	8
Half continuance in total darkneſs			22	41
27. 11. 60. : 22. 41. to half duration in total darkneſs			50	4
Whole duration in total darkneſs		1	40	8

Hence the apparent times at London and Coventry.

London. h. m.		Coventry. h. m.
6 5	Beginning auguſt 29th evening	5 59
7 9	Beginning of total darkneſs	7 3
7 59	Greateſt obſcuration	7 53
8 49	End of total darkneſs	8 43
9 52	End of the eclipſe	9 46
3 47	Whole duration	



This type ſhews upon the figur'd line of the moon's way, the time of the beginning, immerſion, greateſt darkneſs, emerſion and end, by the place of the moon's center on that line, at her paſſage through the dark ſhadow of the earth: the other lines of the moon's eclipſes, in my laſt, I explain'd, ſo needleſs here. The moon's latitude at the beginning is 16 ſeconds north deſcending, and at the end 9′ 38″ ſouth deſcending.*

On the 5th of march, at 3 afternoon, and 13th of ſeptember, at 9 morning, moon's eclips'd inviſible. On the 19th of february, at midnight, and 15th of auguſt, at 2 in the morning, ſun's eclips'd inviſible.

Note, The 29th of auguſt the moon riſes not till 20 minutes after the beginning of the eclipſe.

Paradoxes

* *This eclipſe of Aug. 29th was obſerved thus.*

Places	Obſervers	Begin. h. m. s.	To. Im. h. m. s.	Emerſi. h. m. s.	End. h. m. s.	
Padua	J. Poleni		7 49 4	9 36 4	10 41 2	Ap. time
Bologna	G. Rondelli		7 47 40	9 27 40	10 37 36	Tr. time
Bologna	G. Manfredi	6 42 13	7 47 50	9 29 20	10 38 51	Tr. time
Bologna	A. Giſilieri	6 40 23	7 46 37	9 33 50	10 37 42	
London	M. Folkes		7 2 0	8 46 20	9 52 0	
Wanſtead	Dr. Pound		7 2 41	8 48 18	9 53 0	Ap. time

Paradoxes to be anſwered next year.

Par. 1. There's a certain country in South America, many of whoſe ſavage inhabitants are ſuch unheard of canibals, that they not only feed upon human fleſh, but alſo ſome of them do actually eat themſelves; and yet they commonly ſurvive that ſtrange repaſt.

Par. 2. There's a certain European city, whoſe buildings being generally of firm ſtone, are (for the moſt part) of a prodigious height, and exceeding ſtrong: yet it is moſt certain, that the walls of thoſe buildings are not parallel to one another, nor perpendicular to the plain on which they are built.

Par. 3. There are two diſtinct places on the continent of Europe, ſo ſituated in reſpect to one another, that tho' the firſt lies eaſt from the 2d, yet the 2d is not weſt from the firſt.

Par. 4. There's a remarkable place on the globe of the earth, of a very pure and wholſome air to breathe in, yet of ſuch a ſtrange and deteſtable quality, that it's abſolutely impoſſible for two of the intireſt friends that ever breathed, to continue in the ſame in mutual love and friendſhip for the ſpace of two minutes of time.

I deſign next year ſome new paradoxes, which I doubt not my correſpondents will compoſe for this place.

New

In this year, from the 18th of January to the 5th of February, new ſtile, a *Comet* was obſerved at *Berlin* by Mr. *Chriſt. Kirk*, thus:

At 10 at night		Longitude		Latitude	
Jan.	18	27°	26′ ♋	69°	18′ No.
	21	16	25½ ♉	48	42
	23	9	28½	39	45
	26	5	25½	32	55
	27	4	41	31	24
	28	4	4	30	13
	30	3	4	28	23½
	31	2	43	27	40
Feb.	1	2	25	27	1
	2	2	10	26	22
	5	1	39	24	53

From theſe obſervations it is found that the comet's deſcending node was in about 21½ degrees of Aries; the angle of its orbit and ecliptic 69½ degrees, it paſſing within 2 or 3 degrees of the pole of the world, and cutting the equator at about 20½ deg. from the equinoctial point; its perigeon was in 6° 6′ ♍ with 67° 7′ north latitude, it being in its perigeon Jan. 18. 3h. 9min.

New Questions.

I. *Question* 59, *by Mr.* Doidge, *of Portsmouth.*

One ev'ning, as I walk'd to take the air,
I met a damſel beautiful and fair:
Her matchleſs charms did fix my roving heart,
Which, till that moment, ſcorn'd love's proudeſt dart.
Unto this fair I did myſelf addreſs,
With all the love that lovers can expreſs.
Then ſtreight unto her father's houſe we went,
And in love's ſtories all the time we ſpent.
A curious garden joined thereunto,
And all that lovely was, i'th' ſame there grew:
The ſilver ſtreams, and pleaſant walks ſo nice,
Made it appear like to a paradiſe.
Amidſt the garden ſhe a knot would place,
The better ſtill her garden for to grace.
The content of it ſhould exact agree,
To be in feet one hundred ſixty-three:
A polygon's the form; but it muſt bear,
Of juſt ten equal ſides, and regular.
Then ſir, ſaid ſhe, pray try your ſkill to find
The ſide's true length, to form the knot deſign'd.
And to reward the pains you take for me,
I freely then your wedded wife will be.
Theſe words with joy ſo fill'd my breaſt, that I
Thought that each moment was eternity,
Until that I the ſide's true length had found,
And then in pleaſure evermore abound.
But ah! with pains I've try'd all ways about,
And all in vain; I cannot find it out.
Aſſiſt, fair ladies, one with grief oppreſt,
And ſend an anſwer to this one requeſt.

II. *Question* 60, *by Mr.* Tho. Cary, *of Lynn.*

Within my garden I've a pond that's round,
Whoſe ſurface equal to $5028\frac{4}{7}$ ſquare feet is found:
In th' midſt of which, a pole ſtands juſt upright
Above the plain, one hundred feet in height:
This pole being broke into two parts,
Come, tell this query now, ye men of arts.
The broken piece fell juſt at the pond's brink:
How long is then the piece left, do you think?

III. *Question*

III. *Question* 61, *by Mr.* Peter Ward.

You that delight in figures, try your ſkill,
A magic ſquare with numbers for to fill:
One to a hundred numbers there muſt be;
Which to the numbers of the ſquares agree:
But farther ſtill you muſt them ſo contrive,
Twenty-two ways to make five hundred and five.
No two ſquares alike in numbers muſt be;
But ten in length, and ten in breadth, let's ſee.

IV. *Question* 62, *by Mr.* Wm. Whitworth, *of Northampton.*

Ingenious ſons of art, I new requeſt,
That you my artificer will aſſiſt.
Alſo be pleas'd to let me underſtand,
How to effect my purpoſe now in hand.
A ciſtern made of lead that's half inch thick,
In oblong priſm form; but honeſt Dick
With me agreement made the length to be
In ratio to the breadth, as five to three;
And muſt hold fifty buſhels exactly.
But this is what I moſt of all deſire,
To have it, that the leaſt lead will require;
That is, what will the leaſt of ſurface have,
Is what from you, I with ſubmiſſion crave.
Alſo its length and depth to me expound,
And what 'twill coſt at three half pence a pound.

V. *Question* 63, *by Mr.* Lewis Evan, *from Carmarthenſhire*

Ten partners bought the hay next year to grow
Upon the meadow field deſcrib'd below.
The price is forty pounds. The mead contains
Juſt ſixty acres, or ſix hundred chains.
A pays a ſum to be found out, and *B*
Does pay five ſhillings more than *A*; ſo *C*
Five ſhillings more than *B*; the ſame exceſs
Continues to the end; nor more, nor leſs.
Three ſides it has, whereof the baſe is fifty,
O'th' two ſlope lines, the longeſt meaſures forty,
The other thirty chains. This mighty care
Torments their minds, how ev'ry one's due ſhare
According to the money he pays in,
Shall be laid out by 'tſelf. For they begin
To think, no other way will do ſo well;
That partnerſhips are tedious, moſt can tell.

At the acuteſt angle, they've indeed
Amongſt themſelves moſt willingly agreed,
A's ſhare ſhall be, the reſt in order on,
B, *C*, *D E*, ſo forth, till all is done;
Thoſe perpendicular lengths, which from the baſe,
Erected at right angles, ſhall thoſe ſhares
Divide aſunder: and how many chains
O'th' baſe each ſhare takes up: Whoe'er the pains
Shall take to ſhew, himſelf may well aſſure,
He ſhall thereby their heartieſt thanks procure.

VI. *Queſtion* 64, *by Mr.* Rob. Beales.

A young man had left him by his old grannum
Two hundred pounds; but nothing per annum.
'Twas not to be paid him till nine years three quarters,
Which vexed him ſore, and put him to tortures;
'Cauſe being juſt marry'd, he wanted the pelf,
Which made him bethink what to do with himſelf.
So he went to a miſer, whoſe riches were great,
And did the whole ſtory unto him relate;
Who ſaid, if his ſtory in truth could be found,
He'd venture to give him one hundred pound
Then down on the nail; which made him look brave,
And tell the old lurch, the full ſum he ſhould have,
As above, at the time: ſo ſecur'ty was made,
And an hundred pounds he had got for to trade.
Now what compound int'reſt did the miſer demand,
Per cent. per annum for the money in hand?

The Prize Queſtion, 10 *diaries to the anſwerer.*

Ladies, as you ſet many right,
Pray do the ſame for a wheelwright;
And for your pains I will content you,
If you explain this paper ſent you.
In two wheels if there be inſcribed
A polygon that's equal ſided;
The leſs five ſides, the other ſeven;
Of which the areas they are given
In proportion or analogy,
Exactly as thirteen to three.
But theſe to find, depends upon
The juſt length of a pendulum
That vibrates ſixty times and one
Exactly in one minute's ſpace:
This, being found, is the true baſe

To

To two ſides of the pentagon;
And bounds the angle (which is known).
Then by the length of this ſubtenſe,
Or baſe, there will by inference,
Be found the parts of ev'ry figure,
Firſt of the leſs, and then the bigger:
Alſo each wheel's periphery;
For that directs the ſmith and me.
And for that lady's courteſy,
Who firſt ſends theſe true lengths to me,
I'll give next year ten ladies' diaries,
As prize for anſwering theſe queries.

1719.

Anſwers to the Paradoxes propoſed laſt year.

Par. 1. ADraſtea ſays, If they don't eat (their meat) themſelves, who can eat for them, in ſuch manner as to ſuſtain their life?

Par. 2. All walls are endeavour'd to be built perpendicular to the tangent (and point to the center) of the earth, where they, if continued, would meet in a point, and conſequently are not parallels, and but in one point only can a perpendicular be raiſed on a horizontal plain: vid. 5th par. 1715, anſwer'd in the diary for 1716, and *Euclid.* lib. 11 pr. 13.

Par. 3. Any two places on the globe that differ in, or have latitude.

Par. 4. This paradox by ſome anſwer'd thus. 'Tis impoſſible for two perſons to be in one and the ſelf-ſame individual place together.

Others ſay, two in the throne can't continue in mutual love and friendſhip.

Mr. *Hum. Marſhjuſtum* ſays, by reaſon of the earth's motion they cannot continue in the ſame air.

Solutions

Solutions to the last year's questions.

* I. *Question* 59, *answer'd by* Anna Philomathes.

Sir, my affiftance ne'er fhall wanting be,
To eafe a friend that's in extremity.
When firft I found how you with grief were prefs'd,
A moving pity touch'd my tender breaft;
Alas! thought I, his ruin is too fure,
If there's no way but this to work the cure;
But viewing well the query o'er again,
I found the antitode that cures your pain.

55·23 inches = to the polygon's fide = 4·602 feet.

† II. *The 60th queftion anfwer'd by Mr.* W. Laughton.

Let r = 40·008 the radius of the pond; h = to the piece broke off; and p = to ftanding piece. Then $h + p = a =$ 100,

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* I. QUESTION 59 *folved.*

By menfuration, $\frac{5}{2}\sqrt{5 + 2\sqrt{5}}$ or 7·6942088 drawn into the fquare of the fide of a decagon is its area; wherefore the fide will be $\sqrt{\frac{163}{7 \cdot 6942088}} = 4 \cdot 6027$ nearly.

† II. QUESTION 60 *folved.*

Algebraically.

The fquare of the radius of the circle is $\frac{5028\frac{4}{7}}{4 \times \cdot 78539 \text{ \&c.}} = \frac{8800}{7 \times \cdot 78539 \text{ \&c.}} = 1600 \cdot 644$, which put $= a^2$; alfo put $c = 100$ the whole height of the pole, and $x =$ the part ftanding. Then will $c - x$ be the part broken off, and is the hypothenufe of a right-angled triangle whofe two legs are a and x; confequently $a^2 + x^2 = \overline{c - x}|^2 = c^2 - 2cx + x^2$; and hence $x = \frac{c^2 - a^2}{2c} = 41 \cdot 99678$ = the length required.

Geome-

100, and $hh = pp + rr$ by 47 Euclid 1. Hence $hh + 2hp + pp = aa$. And $hh - pp = rr$. By ſubtracting, $2hp + 2pp = aa - rr$. Then $p = \frac{aa - rr}{2h + 2p} = \frac{aa - rr}{2a} = 41{\cdot}9968$ feet.

III. *The* 61*ſt queſtion anſwer'd by Mr.* Mich. Eling, *Mr.* Jo. Smith, *Mr.* Williams, John Tinder, Alex. Naughley, J. Clifford, J. Simmons, W. Kendall, *and* W. Rubens; *but there are many different ways of anſwering or filling this magic ſquare.*

The following one is thus fill'd by Mr. *J. Harris.*

11	92	12	88	14	15	16	84	83	90
100	82	26	27	67	35	59	58	50	1
99	19	75	74	33	66	42	43	51	3
2	20	76	73	34	36	60	57	49	98
4	81	25	28	68	65	41	44	52	97
94	21	77	72	32	37	61	56	48	7
5	80	24	29	69	64	40	45	53	96
6	79	23	30	70	38	62	55	47	95
93	22	78	71	31	63	39	46	54	8
91	9	89	13	87	86	35	17	18	10

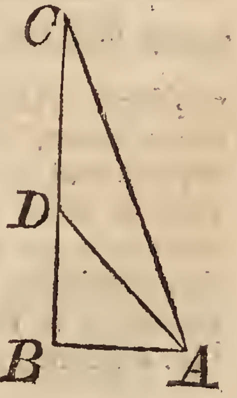
Theſe numbers make 505 ten times in the lines, ten times in the columns, and twice diagonally.

IV. The

Geometrically.

Here are given the baſe and the ſum of the hypothenuſe and perpendicular, of a right-angled triangle; to conſtruct the ſame. Which will be done thus:

Making AB the radius of the circular pond, and BC the pole perpendicular to it; join A, C; and draw AD making the angle $DAC = \angle DCA$; ſo ſhall BD be the part ſtanding, and DA or DC the part broke off.——For, becauſe of the equality of the $\angle$s DCA, DAC, their oppoſite ſides DA, DC will be equal. *Q. E. D.*



IV. The 62d question answered by *Anna Philomathes*, who for the honour of the fair sex, I can assure the world, from an ocular demonstration at a visit I once made her, that these mathematical performances are purely her own.

Your problem, Mr. *Whitworth*, I have told,
Tho' found it somewhat knotty to unfold.
Did you think it beyond our sex's parts,
That assistance you crave from the sons of arts?
If you'll please to view here what I write below,
Full answer to your queries I will show.

Let $b = 5$, $c = 3$, and $aaa = 107520$ = cubic inches in 50 bushels, also let x = length: then will $\frac{cx}{b}$ = to breadth, $\frac{baaa}{cxx}$ = to the depth, and $\frac{ccxxx + 2bbaaa + 2bcaaa}{bcx}$ = to least superfi. of cist.*

The

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* IV. QUESTION 62 *solved*.

The above original solution is false as well as that given in the *Diarian Repository*, they both making the internal surface a *minimum*, which is contrary to the intention of the question; for it expresly declares "To have it that the least lead will require" and consequently the difference between the solids made up of the external and internal dimensions must be the *minimum*. Wherefore putting the

$$\text{internal}\left\{\begin{array}{l}\text{length} = 5x\\ \text{breadth} = 3x\\ \text{depth} = y\end{array}\right\},\ \text{the external dimensions will be}\left\{\begin{array}{l}5x+2 = \text{length}\\ 3x+1 = \text{breadth}\\ y+\tfrac{1}{2} = \text{depth}\end{array}\right\}.$$

And hence $15x^2y = 107520$, and $\overline{5x+1} \cdot \overline{3x+1} \cdot \overline{y+\frac{1}{2}} - 15xy$ or $\frac{15}{2}x^2 + \overline{8x+1} \cdot \overline{y+\frac{1}{2}}$ = a *minimum*. The value of y being exterminated out of this equation, by means of the first, and its fluxion put $= 0$, we at last obtain $15x^4 + 4x^3 - 57344x - 14336 = 0$; in which equation the root x is $= 15{\cdot}630773$. Wherefore $5x = 78{\cdot}135865$ = internal length, $3x = 46{\cdot}892319$ = internal breadth, and $y = \frac{107520}{15xx} = \frac{7168}{xx} = 29{\cdot}338444$ = internal depth; also, by adding 1 to each of the former numbers and $\frac{1}{2}$ to the latter, we have 79·153865, 47·892319, and 29·838444 for the external length, depth, and breath. From the continual product of these three taking 107520 the content of the inside, there remains 5594·34 for the cubic inches of lead in the cistern; and this multiplied by ·409618 *lb.* the weight of a cubic inch of lead according to *Ward*, the product is 2291·54 *lb.* of lead, which at $1\frac{1}{2}$*d.* a-pound, amounts to 14 *l.* 6 *s.* 5 *d.* 1·24 *q.*

The fluxion thereof is $\frac{2ccx^3\dot{x} - 2bba^3\dot{x} - 2bca^3\dot{x}}{bcxx} = 2ccx^3\dot{x} - 2bba^3\dot{x} - 2bca^3\dot{x} = 0$. Therefore $x = \sqrt[3]{\frac{bba^3 + bca^3}{cc}}$ = length = 78·181426 inches, $\frac{cx}{b}$ = breadth = 46·9088 inches, and $\frac{ba^3}{cx}$ = depth = 29·318 in.

The purchase 14 *l.* 1 *s.* $7\frac{3}{4}$ *d.*

* V. *The* 63*d question answered by* A. Philomathes, T. Dodd, H. Walker, W. Crabb, Jo. Smith, W. Hawney, J. Jennings, C. Chorley, J. Finclair, Geo. Nash, A. Naughley, G. Hare, Ja. Royston, Mary Nelson, J. Clifford, J. Simmons, Jo. Wilkinson, Beata White, *and* John Cunning.

Sharers.	Mustpa.	Share of	Len. on base	Length perp
	l. s. d.	*a. r. p.*	chains	chains
A	2 17 6	4 1 10	10·723	8·04
B	3 2 6	4 2 30	4·768	11·62
C	3 7 6	5 0 10	3·873	14·52
D	3 12 6	5 1 30	3·438	17·10
E	3 17 6	5 3 10	3·177	19·48
F	4 2 6	6 0 30	3·002	21·73
G	4 7 6	6 2 10	2·876	23·89
H	4 12 6	6 3 30	3·140	20·00
I	4 17 6	7 1 10	4·261	14·32
K	5 2 6	7 2 30	10·738	a △
Sum	40 0 0	60 0 0	49·999	

VI. The

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* V. QUESTION 63 *solved.*

By the nature of arithmetical progression, having given the common difference 5 = *d*, the number of terms 10 = *n*, and the sum of the series 40 × 20 = 800 = *s*; there will be found the first term

* VI. *The 64th question resolved by* A. Philomathes, T. Dodd, Lewis Evan, W. Crabb, J. Smith, W. Hawney, W. Armstrong, W. Loughton, J. Jennings, C. Chorley, Anne Harris, J. Tefft, *and several others.*

The miser demanded $7\,l.\ 7\,s.\ 4\frac{1}{4}d.$ per cent. per ann. comp. int.

The

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term $a = \frac{2s - dn \cdot \overline{n-1}}{2n} = \frac{1600 - 450}{20} = 57\frac{1}{2}s. = 2\,l.\ 17\,s.$ $6\,d.$ = *A's* share of the money, and by the constant addition of $5s.$ all the rest will be found to be as in the 2d column of the original solution above.

Then, their shares of the field will be in proportion as their sums of money, and since the triangle is evidently right angled, and its area $= 30 \times 20 = 600$ chains $= 60$ acres, we shall have, as $40\,l.$: 60 acres or as $2 : 3 :: 2\,l.\ 17\,s.\ 6\,d. : 4{\cdot}3125$ acres $= 4\,ac.\ 1\,ro.$ 10 poles = *A*'s share, and as $2\,l. : 3 :: 5\,s. : {\cdot}375\,ac. = 1\,ro.\ 20\,po.$ = the common difference; which being continually added will give the several shares as in the 3d column.

Again, for the bases and perpendiculars: Since the first and last parts are triangles similar to the whole field, and similar triangles being as the squares of their like sides, we shall have, as

$$\sqrt{60} : \sqrt{4{\cdot}3125} :: \begin{cases} 40 : 10{\cdot}723 = A\text{'s base} \\ 30 : 8{\cdot}042 = A\text{'s perpendicular,} \end{cases}$$

$$\text{and } \sqrt{60} : \sqrt{7{\cdot}6875} :: \begin{cases} 40 : 14{\cdot}317 = K\text{'s perpendicular} \\ 30 : 10{\cdot}738 = K\text{'s base.} \end{cases}$$

Then to the first and last areas add their adjacent ones, and the sums will be the next similar triangles; whose sides being calculated in the same manner, their perpendiculars will be those in the last column, and the differences of the bases will be the bases in the column next to it.

* VI. QUESTION 64 *solved.*

If r be put for the rate of $1\,l.$ by the nature of compound interest, we shall have $100 \times \overline{1+r}|^{\frac{39}{4}} = 200$, or $\overline{1+r}|^{\frac{39}{4}} = 2$, or $\overline{1+r}|^{39} = 2^4 = 16$; and $r = 16^{\frac{1}{39}} - 1 = {\cdot}07368$. Hence the rate *per cent.* is $100 \quad {\cdot}07368 = 7{\cdot}368 = 7\,l.\ 7\,s.\ 4\,d.\ 1{\cdot}28\,q.$

The Prize Question answered by Anna Philomathes, W. Hawney, Josiah Clayton, J. Buckey, Philomathematica, Luke Cullimore, Mary Nelson, Jo. Smith, E. Elphick, C. Mason, T. Orme, Henry Hale, J. Jennings, Ja. Pearce, W. Doidge, Cha. Chorley, Anne Harris, *and* W. Whitworth, *before Candlemas-day, and afterwards by* Tho. Cary, J. Cary, G. Hare, J. Stocks, R. Whitehead, Beata White, *and* Peter Ward.

W. Whitworth's *answer.*

The lengths of pendulums are reciprocally proportionable to the squares of their vibrations.

Therefore as sq. $61 = 3721 : 3600 :: 39.2 : 37.9252 = b$ the subtense, whence the side a must be found by this theorem: *If a quadrangle be inscribed in a circle, the rectangles of the two diagonals will be equal to both the rectangles af the opposite sides.*

Now the diagonals being each equal to the subtense b, the theorem is $aa + ba = bb$; ergo, $a = \sqrt{bb + \frac{1}{4}bb} - \frac{1}{2}b =$ 23.439062 inches, the side of the pentagon.

Then b being the hypothenuse of a rectangle triangle described in a circle, and cd part of the diameter (as far as where the perpendicular falls) the base; the perpen. being a and the other part of the diam. df; we have $\sqrt{bb - \frac{aa}{4}} = cd$; and $\frac{1}{4}aa \div cd = df$; and $cd + df =$ diamet. required. Also the area of the pentagon will be 945.210782. Then 3 : 13 :: 945.2107 : 4095.9133912 = area of heptagon, 3.633912 : 1 :: 4095.91 in duplicate ratio, to side of the heptagon. Then the other parts are easily found, as below.

Parts.		Pentagon.		Heptagon.
The area of the ———	—	945.2107	—	4095.9133
Diam. of circum. circle	—	39.8768	—	76.8283
Diam. of inscribed circle	—	32.2611	—	69.1047
Circumscribing circle —	—	125.2768	—	241.3637
Inscribed circle — —	—	101.3510	—	217.0994

Of the Eclipſes in 1719.

Four times this year, in their natural courſe, will the ſun and moon be deprived of giving light to us; the calculation I have ſupputated form *Aſtronomia Carolina*, the tables of the celebrated Mr. *Tho. Street.*

1. Sun eclipſed the 8th day of february, at 6 o'clock in the morning, the ſun being then not riſen, can't be ſeen by us in the britiſh iſlands, but in the eaſtern countries it will be a conſiderable deliquium.

2. Moon eclipſed on the 23d. of february, at 50 min. after 7 in the morning, but the ſun riſing half an hour before 7, the moon conſequently muſt be ſet, as being then diametrically oppoſite, ſo the moon immerges juſt as the eclipſe begins, and makes it inviſible to us; but to the Weſtern iſlands it will appear 5 digits eclipſed on her ſouthern limb.

3. Sun eclipſed on tueſday the 4th day of auguſt, at 6 in the afternoon; but it may be inviſible, the moon's ſouth latitude ſo depreſſes her as not to interpoſe between the ſun and our ſight.

4. Moon eclipſed, and viſible on tueſday the 18th day of auguſt, at 8 o'clock in the evening.

	h.	m.	s.
The equal time of the true ☍ at Coventry — —	7	44	3
The time of reduction add — — — —		3	23
Correct time of true ☍ in the ecliptic — —	7	47	26
Æquation of time add — — — —		2	36
The apparent time of ☍ — — — —	7	50	2
Interval of the true ☍ and the greateſt obſcur. ſub.		6	46

Hence at Coventry, Auguſt 18th evening.

	m.	h.
The beginning — — — — —	VII	18
The middle or greateſt obſcuration — —	VIII	15
The end — — — — — —	IX	13
The whole duration — — — —	I	55
Digits eclipſed north — — — —	3 D. 3′. 42″.	
The latitude of the moon at beginning —	42′. 55″. S. D.	

Latitude at the end, 48′ ſouth deſcending.

It

It would be much for the improvement of aſtronomy, and honour of our nation, if perſons who have well adjuſted pendulums and proper inſtruments, would obſerve the times and parts of the eclipſes, and communicate them; that eclipſe of ☽ 9 ſept. 1717, was obſerved in latitude 55 to be obſcured about 7 digits.

The three obſervations following were made and adjuſted to the city of Coventry by an accurate hand.

1717.	Oct.	9 d.	13 h.	12′	40″	Jupiter's 3d ſatellite emerged.
1717.	Dec. 5		9	22	00	Jupiter's 2d ſatellite immerg.
1717.	Jan. 28		7	16	40	Jupiter's 1ſt ſatellite emerged.

New Paradoxes.

1. There are divers places on the continent of Africa, and the iſlands of Sumatra and Borneo, where a certain kind of ſun-dial being duly fix'd, the gnomon thereof will caſt no ſhadow at all, during ſeveral ſeaſons of the year; and yet the exact time of the day may be known thereby.

2. There is a certain iſland (whereof mention is made by ſeveral of our lateſt geographers) whoſe inhabitants cannot properly be reckoned either male or female, nor altogether hermaphrodites: yet ſuch is their peculiar quality, that they're ſeldom liable to either hunger or thirſt, cold or heat, joy or ſorrow, hopes or fears, or any ſuch of the common attendants of human life.

3. There is a very remarkable place upon the terraqueous globe, where all the planets, notwithſtanding their different motions and various aſpects, do always bear upon one and the ſame point of the compaſs.

4. There is a large and famous country on the continent of Africa, many of whoſe inhabitants are born perfectly deaf, and others ſtone-blind, and continue ſo during their whole lives; and ſuch is the amazing faculty of thoſe perſons, that the deaf are as capable to judge of ſounds, as thoſe that hear, and the blind of colours, as thoſe that ſee.

5. *Scholaſticus* ſends the following in latin, out of *Owen*'s epigrams.

Dic quibus hoc animal terræ naſcatur in oris,
Maſculus eſt matur cui, mulierque pater.

New Questions.

I. *Question* 65, *by Mr.* Henry Walker.

When firſt *Columbus*, with advent'rous mind,
The ocean croſs'd, a weſtern world to find,
With him a gentle Spaniard, young and fair,
Saw, and confeſs'd the power of beauty there:
An Indian virgin firſt engag'd his love;
She innocent, his paſſion did approve;
And crown'd the happy lover, I am told,
With native beauty, and with native gold.
A wedge of gold (herſelf the lovelier prize)
She brings; whoſe length and depth who multiplies,
Produces ninety-ſix; the breadth by depth fourſcore,
The length by th' breadth one hundred twenty more.
The ſides true meaſures, what, I do demand;
And would the wedge's value underſtand?

II. *Question* 66, *by Mr.* W. Doidge.

In the latitude of 50 forty-eight,
I ſaw a rainbow beautiful and bright;
It bore north-eaſt, three quarters eaſt, as I
By all my care and art could beſt deſcry.
What was it of the clock I fain would know,
And beg that you the ſame to me would ſhow.

III. *Question* 67, *by Mr.* W. Hawney.

What number of * guineas and piſtoles, I pray,
(With no other coin) will one hundred pounds pay?
And how many ways? Pray declare unto me;
And I'll give you a pot whene'er I you ſee.

* Guineas at 21 *s.* 6 *d.* piſtoles at 17 *s.*

IV. *Question* 68, *by Mr.* John Leddell.

Within my garden I've a piece of ground,
A circle's arch that is exactly round:
This arch's ſine, in length juſt 30 feet;
Its verſed ſine in length is ten compleat.
Now I would have this arch continued round,
Till the ſine's length forty five feet is found.
Ye men of arts, now to oblige your friend,
Of this new arch's verſed ſine the length pray ſend.

V. *Question*

V. *Queſtion* 69, *by Mr.* Jo. Smith.

Three countrymen in Lincolnſhire,
A meadow ground did buy
For ninefcore pounds; to their deſire,
In oval form did lie.
The conjugate was forty chains,
The focus point was found
Juſt fifteen chains, by mighty pains,
From th' center of the ground.
Now *A* would in the middle be,
And *Y*'s abſciſſa were
Juſt eighteen chains; whereas that *E*
His ordinate was near
To thirty chains rightly apply'd.
Now what ſhall each man pay?
And how much land? I pray, don't hide
Such things as needful be.

VI. *Queſtion* 70, *by Mr.* J. Dodd.

As viſiting a friend, the other day,
Tho' unprepar'd, I then muſt needs ſurvey
A piece of land, exact triangular;
One ſide of which I only cou'd come near:
Quoth he, This angle once was found to be
Thirty degrees, and minutes forty-three:
The ſides including it when multiply'd
Together, will (if that be any guide)
I formerly have heard, exactly give * 168·75.
In chains * eightſcore and eight, tenths ſeventy-five.
Th' aſſiſtance only of Sir *Jonas Moore*,
Thro' his compendium, I could then procure;
Without the help of any inſtrument,
I'd have the rule to find out the content.

VII. *Queſtion* 71, *by* Alex. Naughley, *of Cumberland.*

A ſtone for a hog-trough, I'd have to contain
Inches five thouſand four hundred; and then
Its length, breadth, and depth, to the ſum muſt amount
Of fifty-ſeven inches, as houſwives account;
And the trough muſt be made exactly to hold
Five Wincheſter pecks; or I'm ſure of a ſcold.
So pray, you fair ladies, ſend me what directions
The workman may want, to find the dimenſions:
Or what they muſt be (like within as without)
An't pleaſe you to ſhow, it will bring us both out.

VIII. *Queſtion 72, by Mrs.* Mary Nelſon.

A captain on the ſeas, who was both brave and bold,
Had taken from his foes a cheſt well fill'd with gold;
Then all his men were call'd; he ſtraightway let them know,
That each ſhould have his ſhare, as is expreſs'd below.
Now, ladies, anſwer this: How many men there were,
And how much money each allotted to his ſhare?

The firſt took one pound and a hundredth part of the remainder. The 2d two pounds and two of the remainder, and ſo on, till the laſt man, who had all that was left. So the money was equally divided. If the number of men were added to the number of pounds in each ſhare, the ſquare of that ſum would be equal to four times the number of pounds they had in the cheſt.

IX. *Queſtion 73.*

Show me how to find, what's the leaſt number
That you can divide without a remainder?
By given diviſors? As the digits nine;
For a true cannon, I'd give a pint o' wine.

X. *Queſtion 74, by Mr.* Crabb.

Let the dimenſions of a ſpheroid caſk
Be ſuch as here are under; then I aſk
The difference in wine gallons, that are
Between the greateſt cube and cylinder
That can be inſcribed in the ſame. Pray try;
And let us know in your next diary.

Diameter at the head	31·8	inches.
Diameter at the bung	40	
Length — —	52·8	

The Prize Queſtion.

The anſwerer may by lot win 10 *of theſe diaries.*

Ladies, I have a wager laid,
Which I ſhall loſe without your aid;
In Turner's yard lay a wheel nave,
Which late was turned in his lathe,
And is, in ſhape, a ſpheroid's fruſtra;
But for the axeltree, there muſt a
Hole be made, whoſe vacuity
The fruſtum of a cone muſt be;
And baſe breadths in analogy,

Or

Or ratio, fixed is and certain,
Being as twice eight is to thirteen;
And the length in inches eighteen.
The hole being made of this ſaid form,
A gallon is to hold of corn,
And two tenths more of cubic inch.
Pray, ladies, help me at this pinch,
And tell the breadth each baſe muſt be.
To find the nave's ſolidity,
Four times the breadth of the bigger baſe
Of the cone's fruſtra (in this caſe)
Is the greateſt thickneſs of the nave;
Thrice the ſaid breadth each end muſt have.
Now, ladies, I moſt humbly crave
Your help in the next diary,
To ſend me the ſolidity;
And alſo the periphery
O'th' hoops that this nave environ
Four inches from each end (of iron).
Having your help, I'm yours till death,
And you'll oblige each philomath.

1720.

Paradoxes anſwered.

Par. 1. A Horizontal dial under the equinoctial line caſts no ſhadow at 12 o'clock twice every year.

Par. 2. If puppets may be called inhabitants, it will anſwer this paradox.

Par. 3. Under either of the poles of the world.

Par. 4. The blind and deaf have capacity to judge of colours and ſounds as well as thoſe that ſee and hear, tho' they want the ſenſes of ſeeing and hearing.

Par. 5. Progenitos vidi numeroſus vere * Gyrinos
Hæc rana, hic bufo; mater hic, illa pater.

* A tadpole, young frog, or toad.

Solutions

Solutions to the queſtions.

* I. *The 65th queſtion anſwer'd.*

A wedge of gold delightful to the eyes,
The charming fair was much the greater prize.

Tho' this queſtion was falſe printed (breadth for depth) in the 10th line, yet the true anſwer was given by ſeveral, but with ſome variety as to the value of the gold, as either ſtandard, pure, or allay'd. The length 12, breadth 10, and depth 8 inches, and if ·10083 inch. = 1 ounce, and the troy pound = 42 *l.* 10 *s.* the value was 33718 *l.* 19 *s.* $9\frac{1}{2}$ *d.*

† II. *Queſtion 66, anſwered by* William Armſtrong.

If the ſun was near the equinox, which is unlimited in the queſtion, it was 33 min. 45 ſeconds paſt 3 evening.

III. *Queſtion*

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* I. QUESTION 65 *ſolved.*

From the queſtion it is evident that the breadth is to the length as 80 to 96, or as 5 to 6, and to the depth as 120 to 96 or as 5 to 4. Now the product of 4 and 5 is 20, which is ſimilar to the product 80 in the queſtion; and each of the proportional numbers 4, 5, 6 will be to the correſponding numbers required, as the root of 20 to the root of 80. Wherefore as ($\sqrt{20} : \sqrt{80} :: \sqrt{1} : \sqrt{4} ::$)

$$1 : 2 :: \begin{cases} 4 : 8 = \text{the depth,} \\ 5 : 10 = \text{the breadth,} \\ 6 : 12 = \text{the length.} \end{cases}$$

Hence the content is $8 \times 10 \times 12 = 960$ inches. And, uſing Ward's tables, $960 \times 10{\cdot}359273$ ounces $= 80 \times 10{\cdot}359273 = 828{\cdot}74184$ *lb.* which at 22 *l.* 10 *s. per lb.* amount to 35221 *l.* 10 *s.* 6 *d.* 3·072 *q.*

† II. QUESTION 66.

In the above original ſolution to this queſtion, it is juſtly remarked that the queſtion is unlimited, as the declination or time of the year ſhould have been given, and then the ſolution would have been very eaſy: For as the rainbow is formed directly oppoſite to the ſun with regard to the obſerver, the bearing of the ſun will be S. W $\frac{3}{4}$ W. ſo that in a ſpherical triangle would be given two ſides (= the colat. and codeclin.) and an angle (the ſun's azimuth or bearing from the north) oppoſite to one of them (the codeclin.), to find their included angle = the meaſure of the time from noon required.

* III. *Queſtion* 67, *anſwer'd by Mrs.* Heſychia.

Guineas ten, forty-four, and ſeventy-eight,
(As I do take it) ſet the matter right;
An hundred and five, ſixty-two, nineteen,
Are all the piſtoles to anſwer each guin.

† IV. *Queſtion* 68 *anſwered.*

The verſed ſine's length 28·2055 feet.

V. *Queſt.*

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* III. QUESTION 67 *ſolved.*

Put x and y for the number of guineas and piſtoles reſpectively, then the number of ſix-pences in them being $43x$ and $34y$, and the ſix-pences in 100 *l.* $=4000$, we ſhall have $43x+34y=4000$; hence $x=\frac{4000-34y}{43}=93-\frac{34y-1}{43}=$ a whole number; conſequently $\frac{34y-1}{43}$ as alſo 5 times the ſame, viz. $\frac{170y-5}{43}$ $=$ a whole number; take this from the whole number $\frac{172y}{43}$ $=4y$, and there remains the whole number $\frac{2y+5}{43}$; from 22 times this whole number, viz. $\frac{44y+110}{43}$, take the whole num- $\frac{43y}{43}=y$, and there remains the whole number $\frac{y+110}{43}$, which put $=p$; then $y=43p-110$, where the leaſt value of p is evidently 3. Subſtitute this value of y in the value of x, and we ſhall have $x=\frac{4000-34y}{43}=180-34p$, in which the greateſt value of p is evidently 5. So that the queſtion admits of only three ſolutions, p having only three values, viz. 3, 4, and 5; and by writing each of theſe numbers for p in the values of x and y, we obtain $x=78$, 44, and 10, and $y=19$, 62, and 105.

† IV. QUESTION 68 *ſolved.*

The right ſine being 30, and verſed ſine 10, by the nature of the circle, the diameter will be $10+\frac{30^2}{10}=100$, and conſequently the radius $=50$. But, by right-angled triangles, the coſine of the arc whoſe right ſine is 45, will be $=\sqrt{50^2-45^2}=5\sqrt{10^2-9^2}$ $=5\sqrt{19}=21\cdot7944947$ &c. which being taken from the radius 50, there remains 28·205505 &c. for the verſed ſine required.

* V. *Question* 69 *answered.*

In the 9th line of this quest. the error of [not] instead of [in] quite alter'd the design; otherwise the answer had been,

A's part 96·65864 pounds
E —— 25·19722
Y —— 58·14413

† VI. *Quest.* 70, *answer'd by Mr.* John Finch, *of Norwich.*

As rad. : to S. giv. angle :: $\frac{1}{2}$ the rectang. giv. : to area 4*a*. 1*r*. 9*p*.

VII. *Ques-*

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* V. QUESTION 69 *solved.*

By the right-angled triangles, the distance between the focus and the end of the conjugate will be $\sqrt{20^2 + 15^2} = 25 =$ the semi-transverse by the nature of the ellipse; then, by case 2 p. 225 Mensuration, $25 - \frac{25\sqrt{20^2 - 15^2}}{20} = 25 - \frac{25\sqrt{4^2 - 3^2}}{4} = 25 - \frac{25\sqrt{7}}{4} = 8{\cdot}4640543$ &c. $=$ the abscissa of *E*'s part.

Now $\frac{8{\cdot}4640543}{50} = {\cdot}169281$, and $\frac{18}{50} = {\cdot}36$; but the tabular areas for these two quotients, in the table of segments at the end of my Mensuration, are ·08799586 and ·25455055, whose sum taken from ·78539816, there remains ·44285175. Also the product of the two axes $= 50 \times 40 = 2000$

Then, by rule 2 p. 244 Mensur. we shall have

$$\left.\begin{array}{l} {\cdot}08799586 \times 2000 = 175{\cdot}99172 = E\text{'s part} \\ {\cdot}25455055 \times 2000 = 509{\cdot}10110 = Y\text{'s part} \\ {\cdot}44285175 \times 2000 = 885{\cdot}70350 = A\text{'s part} \end{array}\right\} \text{in square chains;}$$

their sum being $1570{\cdot}79632 = {\cdot}78539816 \times 2000 =$ the area of the whole ellipse.

Also, by proportion, we have as 1570·79632 : 180*l*.

$$::\left\{\begin{array}{lllllll} 175{\cdot}99172 : & 20{\cdot}1672\,l. = & 20\,l. & 3s. & 4d. & 0{\cdot}512\,q. & = E\text{'s money,} \\ 509{\cdot}10110 : & 58{\cdot}3387 = & 58 & 6 & 9 & 1{\cdot}152 & = Y\text{'s,} \\ 885{\cdot}70350 : & 101{\cdot}4941 = & 101 & 9 & 10 & 2{\cdot}336 & = A\text{'s.} \\ \hline & & 180 & 0 & 0 & 0 & \text{sum.} \end{array}\right.$$

So that the numbers in the original solution are false.

† VI. QUESTION 70 *solved.*

By a known rule for the area of a triangle, we have as 1 : ·510793 (the nat. sine of 30° 43′) :: 84·375 = half the product of the including sides : 43·09817 chains = 4*a*. 1*r*. 9·5707 perches.

* VII. *Question* 71, *answered by Mr.* Nath. Brown, *writing-master at Sleeford, in Lincolnshire.*

$$\left.\begin{array}{ll}\text{Length} & 30\\ \text{Breadth} & 15\\ \text{Depth} & 12\end{array}\right\}\text{ inches without }\left\{\begin{array}{r}23{\cdot}777\\ 11{\cdot}888\\ 9{\cdot}511\end{array}\right\}\text{ within.}$$

† VIII. *Question* 72 *answered.*

The men were 99, and had 99 l. each. The whole 9801 l.

IX. *Ques-*

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* VII. QUESTION 71 *solved.*

Put x, y, z for the length, breadth, and depth of the stone respectively: Then, by the question, $x+y+z=57$, and $xyz=5400$. The question then is unlimited, there being one equation less than the number of unknown quantities. We shall therefore assume another condition, viz. we shall suppose the length to be double the breadth, or $x=2y$: Then, this written for it in the two given equations, we have $3y+z=57$, and $2y^2z=5400$.

Hence $z=57-3y$, which written for it in the last equation, we have $114y^2-6y^3=5400$, or $19y^2-y^3=900$. Here $y=15$. Consequently $x=2y=30$, and $z=57-3y=57-45=12$.

Then, since 5 pecks $=10\times 268{\cdot}8=2688$ inches, and similar solids are as the cubes of their like sides, we shall have as $\sqrt[3]{5400}:\sqrt[3]{2688}$ or as $\sqrt[3]{225}:\sqrt[3]{112}$ or as $\sqrt[3]{3375}:\sqrt[3]{1680}$, that is, as

$$15:2\sqrt[3]{210}::\left\{\begin{array}{l}30:4\sqrt[3]{210}=23{\cdot}77568\\ 15:2\sqrt[3]{210}=11{\cdot}88784\\ 12:\frac{8}{5}\sqrt[3]{210}=9{\cdot}51027\end{array}\right\}=\text{the dimensions}$$

of the hollow.

† VIII. QUESTION 72 *solved.*

Put x for the number of pounds in the chest: Then, by the question, $1+\frac{x-1}{100}=\frac{99+x}{100}=$ the first man's share, and consequently the sum afterwards left $=x-\frac{99+x}{100}=\frac{99x-99}{100}$; again,

* IX. *Queſtion 73 anſwer'd by Mr.* Tho. Fletcher.

Moſt readily, ſir, I'll the number divulge,
Which the margin makes plainly appear. 2520
I'll the canon reſerve till I taſte of your wine:
Pray obſerve, I'm ſchoolmaſter of Ware.

Mr. *Naughley* gives this canon; multiply the higheſt given powers together, and their products continually by every ſuch given prime, as is no component of any of the ſaid powers, or their product, or of any other given prime: So $9 \times 8 \times 7 \times 5 = 2520$ required.

X. *The*

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again, the 2d man's ſhare will be $2 + \dfrac{\frac{99x - 99}{100} - 2}{100} =$ $\dfrac{198 + \frac{99x - 99}{100}}{100} = \dfrac{19701 + 99x}{10000}$, which muſt be = that of the former, that is, $\dfrac{99 + x}{100} = \dfrac{19701 + 99x}{10000}$; hence $9900 + 100x = 19701 + 99x$, and $x = 19701 - 9900 = 9801$ = the number of pounds in the cheſt. And $\dfrac{99 + x}{100} = 99$ = each man's ſhare.

Again, putting z = the number of men, by the queſtion it will be $\overline{z + 99}|^2 = 4 \times 9801$; hence, by extracting the root, $z + 99 = 2 \times 99$, and $z = 99$ = the number of men the ſame with the number of pounds in each man's ſhare.

* IX. QUESTION 73 *ſolved.*

The general rule for this kind of queſtions, is to begin with the greateſt number and deſcend gradually to the leaſt, taking the continual product of them; but omitting ſuch of the leſs numbers or of their factors as are factors of any of the greater ones. So, in this example, 9 muſt be uſed as being the higheſt number; 8 muſt be uſed becauſe neither itſelf nor any of its factors 2, and 4, are factors of 9; 7 muſt be uſed becauſe it is no factor either of 9 or 8; 6 muſt be omitted becauſe one (3) of its factors divides 9, and the other (2) divides 8; 5 muſt be uſed as being no diviſor of either 7, 8, or 9; but 4 muſt be omitted as being a factor of 8, 3 muſt be omitted as being a factor of 9, and 2 omitted as being a factor of 8. The reaſon of all which is extremely obvious.

Then $9 \times 8 \times 7 \times 5 = 2520$ = the leaſt number required.

* X. *Question 74 resolved by Mr.* T. Hill.

As you are Crabb by name, I think by nature too,
I your crab do taste at last, but 'tis with much ado.

The content of the cylinder 182·2503, of the cube 84·2645; the difference in wine gallons 97·9858.

The

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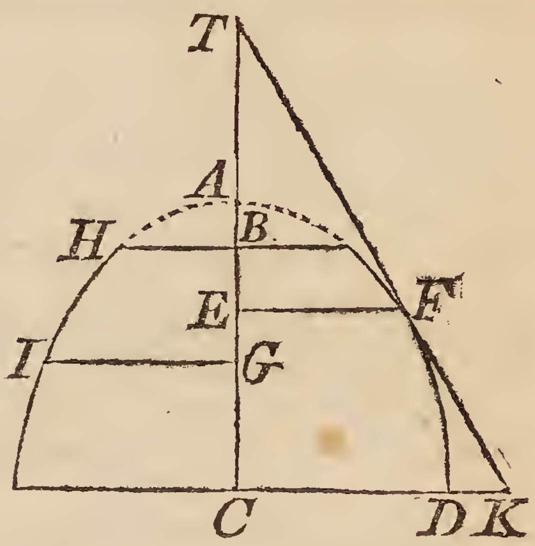
* X. QUESTION 74 *solved.*



Let CB be half the length of the cask, CE and CG half the height of the cylinder and cube respectively; draw the ordinates EF, GI, and to the point F draw a tangent meeting the semi-transverse CA, and semi-conjugate CD, produced, in T and K.

Then, by p. 209 Simpson's Geom. 2d edit. the sub-tangent is twice the altitude of the greatest cylinder, that is, $ET = 2EC$; hence $CT = 3CE$, and $CK = \frac{3}{2}EF$: but, by the nature of the ellipse, $\left\{\begin{array}{l} CE : CA :: CA : CT \text{ or } 3CE \\ EF : CD :: CD : CK \text{ or } \frac{3}{2}EF \end{array}\right\}$ hence $CE = CA\sqrt{\frac{1}{3}}$, and $EF^2 = \frac{2}{3}CD^2$: but, also by the ellipse, $\sqrt{CD^2 - BH^2} : CB :: CD : CA = \dfrac{CD \times CB}{\sqrt{CD^2 - BH^2}}$; and therefore CE (or $CA\sqrt{\frac{1}{3}}$) $= \dfrac{CD \times CB}{\sqrt{3CD^2 - 3BH^2}}$. Hence the solidity of the whole greatest cylinder will be $2CE \times EF^2 \times 3{\cdot}14159$ &c. $= \dfrac{4CD^3 \times CB}{\sqrt{3CD^2 - 3BH^2}} \times \dfrac{3{\cdot}14159 \text{ \&c.}}{3} =$

$$\frac{20^3 \times 26{\cdot}4 \times 4}{\sqrt{3.20^2 - 3.15{\cdot}9^2}} \times \frac{3{\cdot}14159 \text{ \&c.}}{3} = 42100{\cdot}05.$$

Again, CG being half the side of the cube, and GI the radius of a circle circumscribing one face of it, the square of the side of the cube or $4CG^2$ will, by right-angled triangles, be $= 2IG^2$; and hence $IG^2 = 2CG^2$: but, by the ellipse, $CA^2 : CD :: CA^2 - CG^2 : GI^2$ or $2CG^2$; hence $\sqrt{2CA^2 + CD^2} : CD :: CA : CG = \dfrac{CA \times CD}{\sqrt{2CA^2 + CD^2}} =$ (by writing the value of CA

instead

The Prize Question answered by Mr. Whitworth.

Put $b = 13$, $c = 16$, $l = 18$ the length, $d = 269$ the content, $g = {}^{\cdot}78539$ &c. $a =$ leſſer baſe's diam. Then $b : c :: a : \frac{ca}{b}$ = greater baſe's diam. Now the area of the greater baſe, leſſer baſe, and a geometrical mean multiply'd by $\frac{l}{3} = d$, the content, that is $\overline{aag + \frac{ccaag}{bb} + \frac{aagc}{b}} \times \frac{l}{3} = d$, which reduced is $ccaa + bbaa + bcaa = \frac{3dbb}{gl}$: by this equation

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inſtead of it) $\frac{CD \times CB}{\sqrt{CD^2 + 2CB^2 - BH^2}}$; whoſe cube is $\frac{20^3 \times 26{\cdot}4^3}{\overline{20^2 + 2.26{\cdot}4^2 - 15{\cdot}9^2}|^{\frac{3}{2}}} = 19464{\cdot}41 =$ the content of the cube.

The difference of theſe two contents is 22635·64 inches = 97·9898 wine gallons = the difference required.

* PRIZE QUESTION *ſolved.*

Putting $16x$ and $13x$ for the diameters of the ends of the conic fruſtum, and $n = {}^{\cdot}785398$ &c. by cor. 6 p. 156 Menſur. we ſhall have the content of it $= \overline{\overline{16+13}|^2 - 16.13} \times x^2 \times \frac{18n}{3} = 269$ by the queſtion; hence $x = \sqrt{\frac{269}{29^2 - 16.13 \times 6n}} = \sqrt{\frac{269}{633 \times 6n}}$ $= {}^{\cdot}3002989$. Therefore $16x$ and $13x$ become 4·8047824 and 3·9038857 for the diameters of the hole.

The greater diameter drawn into 4 and 3 give 19·2191296 and 14·4143472 for the diameter at the middle and ends of the nave; and conſequently its ſolidity including the hole will be $\overline{14{\cdot}4143472^2 + 2.19{\cdot}2191296^2} \times \frac{18n}{3} = 4460{\cdot}386$; from which taking 269 the content of the hole, there remains 4191·386 for the quantity of the ſolid.

Alſo, by the nature of the ellipſe (ſee the laſt fig.) $CB^2 : CG^2 :: CD^2 - BH^2 : CD^2 - GI^2$; and hence $2GI = 2\sqrt{\frac{CB^2 . CD^2 + CG^2 . BH^2 - CG^2 . CD^2}{CB^2}} = 17{\cdot}8745048$ (CB being 9 and $CG = 5$ by the queſtion); which multiplied by 3·14159 &c. we have 56·15441 for the circumference of the hoop.

equation $a = 3{\cdot}903886$ the leſſer baſe of the cone's fruſtum, and $\frac{ca}{b} = 4{\cdot}804782$ the greater baſe's diameter; whence the

greateſt thickneſs of the nave is — —	19·219128
Each end — — — —	14·414346
The ſolidity of the fruſt. the cavity ſubt.	4191·408136
The diameter 4 inches from the end —	17·874505
Circumference — — — —	56·154402

The lot for the prize fell to *Philomathematrea*.

Of the Eclipſes in 1720.

There can happen but two eclipſes this year, and both of the ſun, but inviſible to the inhabitants of our Britiſh iſlands. One of them is before the ſun's apogæon, and the other after; ſo that the earth's ſhadow, and her atmoſphere, are uncapable of eclipſing the moon.

1. Sun eclipſed the 28th of january, near 11 in the forenoon, at which time the moon's latitude is ſo much ſouth, that the ſhadow will be depreſs'd too far to be ſeen by us.

2. Sun eclipſed the 23d of july, about 3 o'clock in the morning, but ends ere the ſun is riſen.

The total eclipſe of the moon the 29th of auguſt, 1718, I obſerved near Chateſworth, in Derbyſhire: the beginning of total darkneſs 53 min. paſt 6, the end of total darkneſs 45 min. after 8 o'clock, the full end of the eclipſe 48 min. after 9 at night.

Mr. *John Child*, at Kingſthorpe, near Northampton, in Latitude 52¼, obſerved the end of the eclipſe 9 h. 50 min.

Adraſtea, of Wirkſworth, in Derbyſhire, ſent me the calculation of the moon's eclipſe on the 18th of auguſt, 1719, perform'd by her own hand from the Caroline Tables; and altho' the eclipſe will be over before this diary is publiſhed, yet I ought to acknowledge the favour by committing the reſult of her calculations to the preſs.

	h.	′	″
The equal time of the greateſt obſcuration —	8	29	6
Equation of time ſubtract — — —		14	3
Remains the apparent time of the greateſt obſ.	8	15	3
Time of half duration ſubtract — — —		58	0
Remains the beginning of the eclipſe, evening	7	17	3
Semi-durat. add, gives the end of the eclipſe	9	13	3

Duration 1 ho. 56 min. digits eclipſed 3 d. 13 m.

Since there is no viſible eclipſe this year, 1720, I ſhall here inſert one of the moon, which happens in the enſuing year 1721, the 22d of december.

Juſt as I received it in manuſcript from the ſame ingenious gentlewoman.

	d.	h.	m.	s.
The mean ☍ 22d december, 1721 — —	22	4	7	2
Difference from the ☍ parts — — —			45	52
Hourly motion of ☉ 2′ 33″ of ☽ 30′ 7″ dif.			27	34
Interval of mean and true ☍ ſub. — —		1	33	18
The middle time of the ☍ — — —	22	2	33	42
Anomaly ☉ 6. 4. 15. 58. Anomaly ☽ —	11	19	27	0
☉'s place in ♑ — — — —	9	11	46	47
The moon's place in the ecliptic ♋ — —	3	11	57	17
The place of dragon's head ſub. — —	3	11	36	36
Arguments of latitude — — —			20	41
Reduction 5″ ſubtr. latitude of ☽ north —			1	44
Difference of hourly motions — — —			27	36
Reduction contrary to the title add — —				11
Correct equal time in the ecliptic — —		2	33	53
Reduct. ſubt. greateſt obſcuration — —	22	2	33	31
Equation of time add — — —			3	38
Apparent time at London — — —		2	37	9
Difference of meridians ſubtract — —			6	
Apparent time at Wirkſworth — —	22	2	31	9
Half duration — — — —		1	51	40
Beginning of the eclipſe — — —		XII	39	29
End of the eclipſe, evening — — —		IIII	22	49
Lat. ☽ at begin. 5′ 14″ ſou. at the end nor.			6	33

This eclipſe is total to the eaſtern inhabitants, but with us will not, becauſe the ☽ riſes not till the greateſt part is expir'd; ſhe appearing then about 6 digits darkened.

——Et fœcunda facit pectora laudis amor.
Vivitur ingenio; cætera mortis erunt.

P. S. Near Beighton, in Derbyſhire, the 18th of auguſt, 1719, I obſerved the moon's eclipſe about 3 digits 18 min. darkened on her north limb at 26 minutes after 8, and the end at 20 min. after 9, being in duration ſomething longer than the former calculation of mine.

Paradoxes to be anſwered next year.

1. There is a certain people in South America, who are properly furniſh'd with only one of the five ſenſes, viz. that of touching; and yet they can both hear and ſee, taſte and ſmell, and that as nicely as we Europeans, who have all the five.

2. There is a certain place on the continent of Europe, where if ſeveral of the ableſt aſtronomers the world now affords ſhould nicely obſerve all the celeſtial bodies, and that at the ſame inſtant of time; yet the planetary phaſes, and their various aſpects, would be really different to each of them.

3. There is a certain European iſland, the northermoſt part whereof doth frequently alter both its longitude and latitude.

4. There are two diſtant places of the earth lying under the equinoctial line, whoſe difference of longitude is compleatly 86 degrees and a half; and yet the true diſtance between theſe two places is not full 86 Italian miles.

Paradox 5, by Mr. C. Maſon.

Leander to his Hero writ; and ſhe
As oft writ back to ſhew her conſtancy:
When with them both the poſt three times had been,
They had no more than each a letter ſeen.

New Queſtions.

I. *Queſtion 75, by Mr.* Tho. Dodd, *Apr.* 30, 1720.

At Michaelmas laſt, ſeventeen hundred nineteen,
My writings will ſhew, which are yet to be ſeen,
That to me were three hundred and twenty pounds due:
And half of that ſum, beſides forty-two,
Juſt five years after that I might demand;
But would fain have the whole ſomewhat ſooner in hand.
I agree to rebate for the latter ſum too, * *Simp. intereſt.*
At the ſame rate of intereſt * our commons allow;
And I likewiſe expect ſome uſe will accrue,
For my ſixteen ſcore pounds, that laſt year were due.
Now to know on what day, I ſhould be very fond,
To receive my five hundred and twenty-two pound.

II. *Question* 76, *by Mr.* W Crabb.

If the ſide of the face of each body platonic
Be twenty-nine inches, as you may project;
Then good Mr. Gauger, now try to unfold,
How many wine gallons each body will hold?
And to this our author the ſame do impart,
And you'll oblige thoſe that are lovers of art.

III. *Question* 77, *by Mr.* W. Deare.

Upon a friend's requeſt, the other day,
A field triangular I did ſurvey;
The longeſt ſide, ſave one, is juſt 8 chains,
Six ſcore degrees the angle blunt contains,
From which a perpendicular let fall
Upon the baſe, th' alternate * ſegment ſhall
Be $5\frac{12}{13}$ chains. Explore, I pray,
The other ſegment, ſide, and area?

* *Segment or baſe next the ſide required.*

IV. *Question* 78, *by Mr.* G. Hare.

Suppoſe a plane in latitude fifty-three
Decline, and ſhou'd recline, as here you ſee,*
In what latitude ſhall that plane become
An upright? and what declination
Shall this plane have, in that latitude?
And what angle ſhall the meridian
In ſuch a plane make with the horizon.
Style's height and diſtance alſo let me ſee,
What will ſubſtile from meridian be?
As alſo ſhow, where the hour lines will fall
By calculation arithmetical?

* *North-weſt decl.* 43° 15′, *reclin.* 49° 20′.

V. *Question* 79, *by Mr.* John Aſhton.

As I with ſome ladies was drinking of tea,
The weather was pleaſant, and the firſt day of May;
I happen'd t' applaud their briſk genius and wit,
Yet thought mathematics for them not ſo fit;
But nettl'd at this was a learned briſk laſs,
And ſun ſhining plain on a ſpecular glaſs,
To th' top o'th' eaſt corner of the room came the rays;
Let's ſee by your learning? She anſwering prays;

This glaſs is i'th' middle o'th' wall I do ſind,
Horizontally plac'd, which ſtands to th' ſouth wind.
The area o'th' end of the room I here ſhow, [80 foot]
The whole room's dimenſions from hence I would know,
With the time of the day? But I'll tell you below,
That the height of the ſun is exactly the ſame,
As azimuth, I truly do find by the beam.
A diſh of the beſt ſhall then be your due;
But, ladies, the point I refer unto you,
Since your ſex propos'd it, pray tell it me too.

VI. *Queſtion* 80, *by* S. T.

A vacuum in the earthly globe ſuppoſe,
Extended to the ſuperficies cloſe:
Then grant that we above a river have
Of conſtant courſe, and ſwift unalter'd wave:
Twelve yards its breadth; but ſix its depth do ſhow;
A thouſand yards an hour it runs; and ſo
It falls into the vacuum below.
Its time to fill it up, pray let me know?

VII. *Queſtion* 81, *by Mr.* J. Jennings.

A houſe (ſuppoſe) was bought and alſo ſold,
Whoſe coſt exceeds its gain, as I am told,
One hundred and ſixty pounds in gold.
Their ſquares together added, will amount
Unto the ſum * annex'd. Pray, ladies, count * 70600
What is the coſt, and alſo what the gains:
Which if you do, I'll thank you for your pains.

VIII. *Queſtion* 82, *by Mr.* William Doidge.

As I was walking on a ſummer's day,
Thinking to drive the tedious hours away;
I ſaw a cone, whoſe vertex from the ground,
Upon the ſlant, juſt ſixty feet I found.
The true contents of its ſolidity,
Are thirty thouſand feet and ſixty-three;
The perpendicular height o'th' cone to find,
All means I've us'd; 'twill ſure diſtract my mind.
Aſſiſtance, ladies, I moſt humbly crave:
I pray, from ruin do your ſervant ſave.

IX. *Queſtion* 83, *by Mr.* J. Plomley *or* N. M.

From the high croſs in Briſtol two men once ſet out,
Reſolving to travel the whole world about:
The one direct eaſterly ſteering his way;
The other went north, as ſome people do ſay:
The firſt travell'd 7 miles $\frac{455}{21535}$ every day,
The other $11\frac{143}{4307}$: But now I you pray,
How many times round the world muſt they go?
And how many * miles will each travel alſo?
And how many days muſt they be to obtain,
To meet at the croſs aforeſaid again?

* *Reckoning* 360 *degrees, each* 60 *Engliſh miles vulgar computation.*

The Prize Queſtion; the anſwerer may by lot win 10 *of theſe diaries.*

With heads full of ale, joke, pun, and banter,
Two young tyros, who'd talk'd much of Gunter,
Euclid, and Barrow, fell to ſquabble of arts,
Being confident each of his own brighter parts,
I'th' Cyclopædia agreed as a proof,
To find the contents of an old kneading-trough;
Whoſe bottom was turn'd up on this occaſion,
To ſerve as a table, in their potation.
The guinea lugg'd out, a wager was laid,
And into the hands of their landlady paid.
Both fell to ſcrawling, each ſure of the matter;
But diſagreeing, choſe me arbitrator:
And with the dimenſions they to me came poſt;
But when they came in, in good ſooth they were loſt:
No matter, ſays one, we ſhall do well enough,
I remember, five-thirds o'th' breadth of the trough
Reach'd croſs the bottom as a diagonal line,
From the bottom's edge to the upper edge or brim.
Alſo the ſides, ends, and bottom are all
One breadth.——Says t'other, I have not forgotten
11·75 feet is the perimeter at bottom,
And the area is juſt one half of that ſum
In ſquare feet and parts (as ſure as a gun).
Now, ſir, we requeſt you, from this number given,
To find that part's contents o'th' trough, if ſet even
Or level—to the diagonal line?
And how many gallons it will hold in wine?
And alſo the whole trough's vacuity
In inches:——pray tell me how many they be?

1721.

The Author's Preface.

ALthough learning, and the mathematical ſciences, have never wanted the defence of many excellent pens, and met with the higheſt applauſe, thro' all ages, and (moſt) countries in the known world; yet we often find men of ſo baſe a ſpirit, that either from the height of ignorance, or envious ſpleen, they ſtill dare to deſpiſe 'em.

Ars nullum habet inimicum niſi ignorantem.

But moſt generally their envy is levell'd at the female ſex, for (ſay they) learning makes a woman proud and impertinent; 'tis not the buſineſs of their ſex: the management of their families, and religion, ought only to be their ſtudy. But for my part, I cannot ſee that the ſearch after truth and reaſon, the improvement of the mind, and duly rectifying the judgments, by thoſe rules, and unerring opinions, of the wiſeſt men, ſhould any more conduce to the bringing a woman into errors, than the ſearch after virtue ſhould be thought the only way to teach us vice. Nor can I conceive, that a woman who does mathematically demonſtrate, *that the whole is equal to all its parts*, or 2 and 2 make 4, is leſs capable of managing her houſhold, governing her ſervants. and giving her children due education.

Nor will ſhe be the leſs a chriſtian, for underſtanding the ſyſtem of the univerſe; but on the contrary, admire that infinite wiſdom in the Creator, who alone could make and govern things ſo vaſtly ſurpaſſing our comprehenſion. On the other hand, it might as well be ſaid, he who underſtands Horace and Virgil, is incapable to manage his eſtate; or becauſe he underſtands geometry and mathematics, he is unfit to plow, ſow, or buy and ſell the products of the ſame. Whoever ſhould aſſert theſe things, muſt by all the world be thought guilty of the greateſt madneſs or ſtupidity. Ignorance never ſets a value on any perſon, but has always been found a conſtant attendant on ſelf-conceit and impudence; when learning is the way to modeſty and good manners. Ignorance is for ever incapable of knowing and doing right; but knowledge like a diamond poliſhed, more illuſtriouſly ſhines.

Stationers' Hall, London,
the 4th of auguſt, 1720.

Paradoxes

Paradoxes anſwered.

Firſt Paradox anſwer'd.

All the ſenſes are properly by the touch; in ſeeing, the object touches the retina; hearing, the ſound touches the drum of the ear; ſmelling, the effluvias touch the ſenſorium; taſting, the palate, &c.

Second Paradox anſwer'd.

Neither at the center, nor any part of the earth, can any one obſerve all the celeſtial bodies at one and the ſame inſtant of time.

3*d*. This is meant a floating iſland, removing by the ſea.

4*th*. The places are not ſuppos'd on the ſurface of the earth, but nearer to the center, where the longitudes all coincide.

The 5th par. means, with both, not each 3 times; the poſt firſt took Leander's letter, 2d Hero's anſwer, 3d brought it to Leander.

Solutions to the queſtions.

* I. *The 75th Queſtion anſwer'd.*

The author's ſolution is, the payment muſt be April 30, 1721.

II. *The*

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* I. QUESTION 75 *ſolved.*

The ſum 320 *l.* being due the 29th of September, and the other ſum 202 *l.* due juſt 5 years afterwards; the meaning of the queſtion is to find ſuch a day between theſe two times, as that the whole ſum 522 *l.* being then received, neither the receiver nor deliverer may ſuffer any loſs; in which caſe it is evident that the intereſt of the 320 *l.* for the time it is kept beyond the time when it was due, muſt be equal to the diſcount of the 202 *l.* for the time it is received before it is due.

Hence

* II. *The 76th Question anſwer'd by Mr.* Dodd.

The wine that each body platonic will hold,
In the numbers annex'd, is demonſtrably told.
The dodecaedron, ſo much does contain, 809·072 *W. gall.*
The icoſaedron will hold, it is plain; 230·343
Hexaedron's content, in this number I ſhew, 105·58
Thus much the octaedron affords unto you; 49·77
Divide the laſt ſum exactly by 4,
Tetraedron that quantity holds, and no more. 12·442

III. *The*

Hence then, denoting the time for the diſcount by x, and conſequently the time for the intereſt, or till the whole muſt be paid, by $5 - x$; by the rules for intereſt and diſcount, $320 \times \frac{5}{100} \times \overline{5 - x} = 16 \times \overline{5 - x}$ will be the intereſt of 320 for the time $5 - x$, and $100 + 5x : 5x :: 202 : \frac{202x}{20 + x}$ = the diſcount of 202 for the time x, the rate of intereſt being 5 per cent. Conſequently $16 \times \overline{5 - x} = \frac{202x}{20 + x}$; hence $x^2 + 27\frac{5}{8}x = 100$, and $x = 3·239888$. Wherefore $5 - x = 1·76$ years nearly = 1 yr. 277 days; which being added to Sept. 29, we have the 3d of July 1721 for the day of payment.

* II. QUESTION 76 *ſolved.*

By page 404 &c. of my Menſuration, it is found that the ſolidities of the five regular bodies, the ſide of each face being 1, will be thus:

Tetraedron	=	0·11785113
Hexaedron	=	1·00000000
Octaedron	=	0·47140452
Dodecaedron	=	7·66311896
Icoſaedron	=	2·18169499.

Then, ſince ſimilar ſolids are as the cubes of their like ſides, each of theſe numbers being multiplied by 24389 the cube of 29, the products will be the contents of the bodies in inches; and if theſe contents be divided by 231, the inches in a wine gallon, there will reſult the ſeveral numbers of gallons as in the original ſolution.

* III. *The 77th Queſtion anſwer'd by Mr.* Crabb, *Mr.* Allen, *Mr.* Failes, *Mr.* Chorley, *Mr.* Finch, *Mr.* Gurney, *Mr.* Dodd, *and Mr.* White.

24·2787 chains = 2 ac. 1 ro. 28 per.

IV. *Queſtion*

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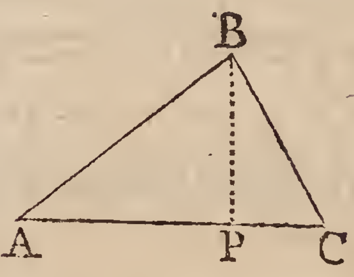
* III. QUESTION 77 *ſolved.*



In this queſtion are given the vertical angle, one ſide, and the alternate ſegment of the baſe; viz. the angle $ABC = 120$ degrees, $BC = 8$ chains, and $AP = 5\frac{12}{13}$ chains.

Put $a = BC = 8$, $b = AP = 5\frac{12}{13}$, $s = \frac{1}{2}\sqrt{3}$ ſine of the angle ABC or $120°$, and $z = PC$. Then, by right-angled triangles, $BP = \sqrt{a^2 - z^2}$, and $AB = \sqrt{b^2 + a^2 - z^2}$; $AB \times BC \times$ ſine $\angle B$ = twice the area $= BP \times AC$, that is, $as\sqrt{b^2 + a^2 - z^2} = \overline{b + z} \cdot \sqrt{a^2 - z^2}$; and this, by ſquaring both ſides, and writing the numbers inſtead of the letters, becomes $48 \times \overline{16745 - 169z^2} = \overline{77 + 13z}|^2 \times \overline{64 - z^2}$, which will be an equation of the 4th order; and by expanding it out, the root z may be found by converging ſeries. But the root will be much eaſier found by the method of Trial-and-Error, from the equation as it here ſtands; and by this method z will come out 7·077 or $7\frac{1}{13}$. Hence the baſe AC is 13, and the area 24·248 ſquare chains.

Scholium.

This problem is the ſame as to divide a given angle into two parts ſuch, that the tangent of the one may be to the ſecant of the other, in a given ratio.

* IV. *The 78th Queſtion anſwer'd by Mr.* Hawney, *Mr.* Failes, *Mr.* White, *Mr.* Williams, *and Mr.* Finch.

	°	′
The dial's new latitude ſouth	4	58
New declination weſt —	26	31
Diſt. of ſubſtile and merid.	78	56
The ſtile's height — —	63	3
Diſtance of merid. and hor.	54	29
Plane's differen. longit. —	80	9

h.	equin. °	′	h. diſt. °	′
VIII	140	9	143	12
IX	125	9	128	20
X	110	9	112	24
XI	95	9	84	18
XII	80	9	78	56
I	65	9	62	33
II	50	9	46	53
III	35	9	32	7
IIII	20	9	18	8
V	5	9	4	36
	Sub—		Stile E.	
VI	9	51	8	48
VII	24	51	22	26
VIII	39	51	36	38

V. *Queſtion*

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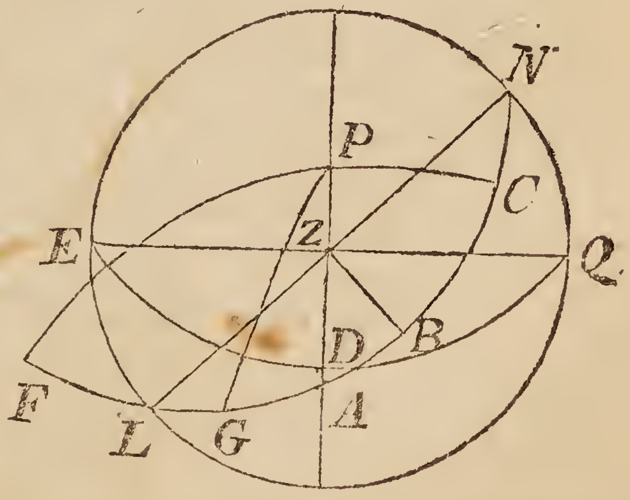
† IV. QUESTION 78 *ſolved.*

The meaning of this queſtion is, that ſuppoſing in the latitude of 53° (north) a plane to face the north-weſt quarter, making an angle of 43° 15′ with the weſt line, and reclining backward towards the ſouth-eaſt quarter 49° 20′, if this plane be moved along the ſame meridian continually parallel to its firſt ſituation, till it becomes an upright plane; to find then the proper requiſites for a dial to be deſcribed on it.

Conſtruction.



Let *ELQN* be the horizon and *Z* the zenith of the place in lat. 53°, *P* the pole, *LZN* the poſition of the plane making the angle *EZL* = 43° 15′, *EZQ* being the prime vertical, *PZDA* the meridian, and *EDQ* the equinoctial. Perpendicular to *LN* draw *ZB* equal to 49° 20′ the reclination, and draw the great circle *LABN*, which will be the plane of the dial, *A* being the new

V. *Question 79 answer'd.*

This question was imperfectly propos'd, no lat. being fixed, so answers may vary for different places. The proposer, in

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place required; also draw the great circle or meridian *CPF* perpendicular to *NALF*.

Then *DA* will be equal to the new latitude south; in which the plane will be upright, the angle *ZAB* the co-declination, *AF* the the distance of the substile from the meridian, *PC* the stile's height, *AL* the distance of the meridian and horizon, and the angle *APF* the plane's difference of longitude.

Calculation.

1. In the right-angled triangle *ABZ*, given *ZB* the reclination $= 49^\circ\ 20'$, and $\angle AZB$ the declination $= 43^\circ\ 15'$. Then

As Cos. $\angle AZB = 43^\circ\ 15'$: Radius :: Tang. $ZB = 49^\circ\ 20'$: Tang. $AZ = 57^\circ\ 58'$; from which taking $ZD = 53^\circ$, there remains $DA = 4^\circ\ 58'$ the new latitude.

As Radius : Sine $\angle AZB$ :: Cos. ZB : Cos. $\angle A = 63^\circ\ 29'$, whose complement $26^\circ\ 31'$ is the new declination.

As Radius : Sine ZB :: Tang. AZB : Tang. $AB = 35^\circ\ 31'$ the complement of $54^\circ\ 29'$ the dist. of merid. and horiz.

2. In the right angled triangle *AFP*, are given $AP = 94^\circ\ 58'$, and $\angle A = (180^\circ - 63^\circ\ 29' =)\ 116^\circ\ 31'$. Then

As Radius : Cos. $\angle A$ :: Tang. AP : Tang. $AF = 78^\circ\ 59'$ the distance of the substile from the merid.

As Radius : S. AP :: S. $\angle A$: S. $FP = 116^\circ\ 57'$, whose supplement $63^\circ\ 3'$ is the stile's height.

As Radius : Cos. AP :: Tang. $\angle A$: Cotang. $\angle P = 80^\circ\ 9'$ the plane's diff. of longitude.

Now this $80^\circ\ 9'$, or plane's difference of longitude, shews that the distance, on the equinoctial *DE*, of the hour line *PA* of 12, is $80^\circ\ 9'$ from the substile *PF*; and which is therefore set opposite to it in the table to the original solution. The equinoctial distances in the same column of the table, belonging to the other hours, are found by the continual addition and subtraction of 15°. And the several distances on the plane of the dial, in the other column of the table, against the equinoctial distances, are all found by this proportion, As Radius : S. $63^\circ\ 3'$ the stile's height :: Tang. of each equinoctial distance : Tang. of the corresponding distance on the plane of the dial. For if *PG* be any hour circle; then, in the right-angled triangle *PFG*, As Radius : S. *PF* :: Tang. $\angle P$: Tang. opposite side *FG*.

Note. In the table to the original solution, for the distance on the plane against the hour XI, the author has set $84^\circ\ 18'$ instead of its supplement; or rather indeedi should be $95^\circ\ 46'$ the sup. of $84^\circ\ 14'$ as appears by calculation.

in latitude 53 28, as alſo Mr. *Crabb*, Mr. *Allen*, Mr. *Finch*, Mr. *Wall*, Mrs. *Dod*, and ſeveral others, anſwer.

Time of the day 2 ho. 6 min. altit. and azimuth 48 20, length of the oppoſite ſide of the room 7·29216 foot, height 10·97, breadth of end walls 3·245, May 1, 1719, London.*

VI. *The*

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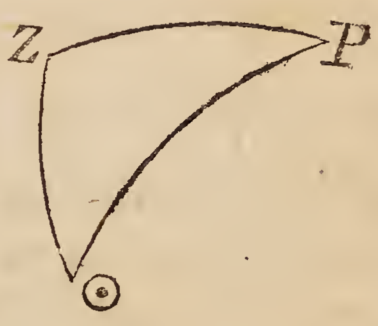
* V. QUESTION 79 *ſolved.*

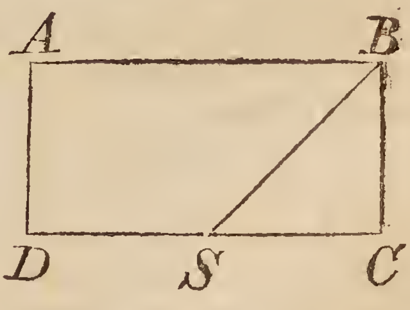


With the above original anſwer, ſuppoſing the latitude to be 51° 32′ that of London. Then, in the annexed figure, if P be the pole, Z the zenith, and ☉ the ſun; we have given $PZ = 38° 28'$ the co-latitude, $P☉ = 72° 6'$ the co-declination for May 1 old ſtile or May 12 new ſtile, and the ſupplement of the angle $Z =$ the complement of $Z☉$; to find the hour angle P.

Put a and $b =$ the ſine and coſine of PZ, $c =$ the coſine of $P☉$, and x and $\sqrt{1-xx} =$ the ſine and coſine of $Z☉$, or coſine and ſine of the $\angle Z$.

Then, by common trigonometry, $axx + b\sqrt{1-xx} = c$. Hence by completing the ſquare and extracting the roots, we obtain $x = \cdot 6937742 =$ the coſine of 46° 4′ the altitude and azimuth. Alſo, as s. $P☉$: s. Z :: s. $Z☉$: s. $P = \frac{x\sqrt{1-xx}}{d}$ (putting $d =$ s. $P☉$) $= \cdot 5250344 =$ the ſine of 31° 40′; which, at 15° to the hour, anſwers to 2 h. $6\frac{2}{3}$ min. afternoon.

Again, if $ABCD$ repreſent the floor of the room, S the ſpeculum in the middle of the ſouth ſide DC, and B the eaſt corner, and SB be drawn; then will the angle B be $=$ 46° 4′ $=$ the azimuth from the ſouth; alſo the triangle formed by SB, the height of the room, and the reflected ray, will be ſimilar to the triangle SBC, becauſe the altitude is equal to the azimuth. Wherefore, if s and c denote the ſine and coſine of 46° 4′ the azimuth, or the ſines of the acute angles of the ſaid two triangles, and z the line SB; then will SC be $= sz$, $CB = cz$, and $c : s :: z : \frac{sz}{c} =$ the height of the room. Now, if the area of



the

* VI. *The 80th Question answer'd.*

In regard the diameter of the earth is variously computed; the answers to this must differ from one another accordingly: Mr. *Crabb* answers 1469,982,847,541 years, according to 60 miles a degree.

† VII. *The 81st Question answer'd.*

250 pound cost, and 90 gain.

VIII. *The*

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the end BC be 80, then $\frac{sz}{c} \times cz = sz^2 = 80 = a$; hence $z = \sqrt{\frac{a}{s}} = 10\cdot54$, and then the breadth $BC = 7\cdot3123$, the length $DC = 15\cdot1804$, and the height $= 10\cdot94$.

But if the area of the side DC be 80; then $\frac{sz}{c} \times 2sz = \frac{2s^2z^2}{c} = a$; hence $z = \frac{\sqrt{\frac{1}{2}ac}}{s}$, and then the breadth $= 5\cdot075$, the length $= 10\cdot536$, and height $= 7\cdot5931$.

* VI. QUESTION 80.

By the question, $6 \times 12 \times 1000 = 72000$ cubic yards of water run in an hour, or $72000 \times 24 \times 365\frac{1}{4} = 631152000$ cubic yards in a year. Now if the circumference of the earth be 21600 nautical miles, then $\frac{21600^3}{\overline{3\cdot14159 \,\&c.}|^2 \times 6}$ nautical miles or $\frac{21600^3 \times 1760^3 \times 7^3}{\overline{3.14159 \,\&c.}|^2 \times 6^4}$ cubic yards will be the content of the earth; which being divided by 631152000, the quotient is 2334289000000 for the number of years required.

So that the first figure in the original answer seems to be falsely printed 1 for 2.

† VII. QUESTION 81 *solved.*

In this question, are given the difference of two numbers, and the sum of their squares, to find the numbers.

Put $d = 160$ the difference, $s = 70600$ the sum of the squares, and $x =$ the cost. Then $x - d =$ the gain, and $x^2 + \overline{x-d}|^2 = 2x^2 - 2dx + d^2 = s$. Hence $x = \frac{d + \sqrt{2s - d^2}}{2} = 250$ the cost, and $x - d = 90$ the gain required.

* VIII. *The 82d Question anſwer'd.*

The perpendicular height 55·5234 feet.

† IX. *The 83d Queſtion anſwer'd.*

The firſt man travels 7 times round the globe, 151200 miles; the ſecond, 11 times, or 237600 miles, and in 21535 days, or 59 years.

The

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* VIII. QUESTION 82.

Put $a = 60$ the ſide, 30063 the content, and $z =$ the perpendicular height Then the radius of the baſe will be $\sqrt{aa - zz}$, the area of the baſe $= \overline{aa - zz} \times 3{\cdot}1416$, and the content $= \dfrac{a^2 z - z^3}{3}$ $\times 3{\cdot}1416 = 30063$; hence $z = 55{\cdot}52446 =$ the perpendicular required.

† IX. QUESTION 83.

It is evident that the number of times round each perſon travels, before they meet, will be directly as his rate of travelling. The queſtion then only requires to be found the leaſt two whole numbers that ſhall be in a given ratio; and ſuch two numbers it is clear muſt be the leaſt integer terms of the ſaid ratio. Now the given terms of the ratio are $11\frac{143}{4307}$ and $7\frac{455}{21535}$ or $7\frac{91}{4307}$; and by dividing the former of theſe terms by 11, and the latter by 7, the quotient of each is $1\frac{13}{4307}$; therefore the leaſt terms of the ratio are 7 and 11, and which of conſequence give the number of times each travels round.

The Prize Question answer'd by Mr. J. Jope, *jun.*

Length at top	5·591	The whole vacuity	18563·74
Breadth —	2·272	Vac. even with diag.	12156·85
Length at bottom	4·5969	Remaining part —	6406·89
Breadth —	1·2780	Liquor, 27·735 wine gallons.	
Depth —	1·1774		
Diagonal —	2·1300		

The prize of 10 *diaries was won by Mr.* Rich. Burnell *of Dewsbury, in Yorkshire.*

Of

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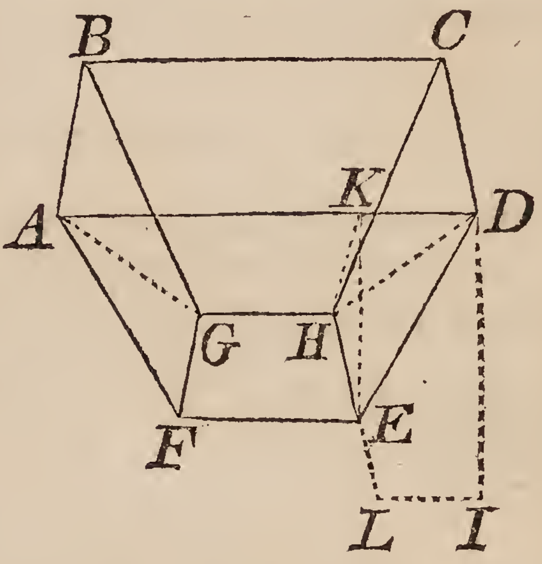
* PRIZE QUESTION.

Let $ABCDEHGF$ be the trough, its depth DI, being a perpendicular from top to the bottom. Then by comparing the words of the question with this figure, the conditions will appear to be thus: Of the rectangle $EFGH$ the perimeter is 11·75, and the area $=$ 5·875; $HE = EK = \frac{3}{5}$ of HK the nearest distance of GH from AD; and HE, EK are also each $=$ the distance between CD and HE, in consequence of which $EL = LI$ will be equal to the half difference of both the lengths and breadths at the top and bottom, and therefore the solid is a prismoid, and not the frustum of a pyramid: And it is required to find the whole content, as well as that of the wedge $ADEHGF$.



Now if x and y denote the length and breadth of the bottom, then $2x + 2y = 11·75$, and $xy = 5·875 = x + y$. From these equations we find $x = 4·597 = EF$, and $y = 1·278 = EH = EK$. And therefore $HK = \frac{5}{3}EH = 2·13$. Then in the obtuse isosceles triangle HEK, by Eucl. II. 12, $EL = LI = \dfrac{KH^2 - KE^2 - EH^2}{2EH}$

$$= \frac{\frac{25}{9}HE^2 - 2HE^2}{2HE} = \tfrac{7}{18}HE = ·497$$ = half the difference between the lengths and breadths; and whose double therefore being added to the length and breadth at bottom, we have $5·591 = AD$, and $2·272 = DC$, the length and breadth at top. Also, by

Of the Eclipses in 1721.

In this year three times the sun and moon are within the bounds of eclipsing, at the conjunction; and three times the sun and moon in opposition, the earth will interpose and eclipse the moon.

1. Moon eclipsed January 2, the greatest obscuration at Coventry 16 min. after 3 in the afternoon, but the eclipse ends as the moon rises, so can't be seen.

2. Sun eclipsed Monday the 16th of January, at 8 o'clock at night, after sun-set, invisible.

3. Moon eclipsed Wednesday the 28th of June, 40 min. past 8 in the morning, the moon being then set, invisible.*

4. The fourth is a visible eclipse of the sun on Thursday the 13th of July, exactly at 8 in the the morning.

	London h.		Coventry		London by Leadbetter		Coventry by Chattock	
The beginning	VII	22	7	16	7	1	7	21
Visible conjunct.	VIII	7	8	1	7	45	8	2
Greatest obscur.	VIII	1	7	55	7	40	7	56
The end	VIII	36	8	30	7	21	8	32
Whole duration	I	13	1	$13\frac{3}{4}$	1	20	1	11
Digits eclipsed	I	15	1	15	1	35	1	13

5. Sun

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by right-angled triangles, $DI = K'L = \sqrt{KE^2 - EL^2} = \sqrt{HE^2 - \frac{7^2 HE^2}{18^2}} = \frac{5 HE\sqrt{11}}{18} = 1{\cdot}1774 =$ the depth of the vessel.

Then, by page 161 Mensuration, the content of the wedge $ADEHGF$ is $\frac{2EF + AD}{6} \times EH \times DI = 3{\cdot}707873$ cubic feet or $= 6407{\cdot}204$ inches $= 27{\cdot}728$ wine gallons. And the content of the wedge $ABCDHG = \frac{2AD + GH}{6} \times DC \times DI = 7{\cdot}034942$ cubic feet $= 12156{\cdot}37$ inches. Also the sum of these two is $10{\cdot}742815$ feet $= 18563{\cdot}57$ inches.

* The 3d eclipse on the 28th of June, was observed by Mr. *Robie* at *Harvard* College in *New England.*

h.	m.	s.	
2	10	0	A thin penumbra.
2	12	0	The shadow is plainly entered.
3	18	30	Moon wholly covered.

5. Sun eclipfed December 8, at 1 in the morning, invifible.

6. Moon eclipfed Friday Dec. 22, total, and part vif. 2 ev.

The time at Wirkfworth by Adraftea's calculation.	h.	m.	Coventry by Chattock		London by Leadbetter	
The begin. evening	XII	39	0	56	0	32
Begin. of total darknefs	I	37	1	39	1	38
The middle —	II	33	2	30	2	27
End of total darknefs	III	18	3	20	3	16
The end ——	IIII	22	4	24	4	21
Whole duration —	3	43	3	48	3	49
Digits eclipfed —	20	48	20	39	20	17
☽'s lat. at begin. fouth	5	10	2	50	——	
At the end north afc.	6	30	7	0	E. M.	

The moon will not rife till near 4 o'clock, and the eclipfe near done.

New Paradoxes.

1. There is a certain place in the ifland of Great Britain, where the ftars are vifible at any time of the day, if the horizon be not o'ercaft with clouds.

2. There is a remarkable river on the continent of Europe, over which there is a bridge of fuch a breadth, that above three thoufand men abreaft may pafs along the fame, and that without crowding one another in the leaft.

3. There is a certain ifland in the vaft Atlantic ocean, which being defcry'd by a fhip at fea, and bearing due eaft of the faid fhip, at twelve leagues per eftimation; the trueft courfe for hitting of the faid ifland, is to fteer fix leagues due eaft, and juft as many due weft.

4. *A Paradox by Mr.* J. Lumley.

The day that I was born, my father he
Laid by five pounds, and faid it was for me:
And when e'er my birth-day came, he never fail'd
To add five pounds (his love fo much prevail'd):
At twenty-four, and upon my birth-day,
I wedded was, my portion he would pay:
Juft thirty-five pounds; (I full twenty-four)
How comes it then my portion was no more?

New

New Questions.

I. *Question* 84, *by Mr.* Sam. Dicker.

Within Megora's city, thro' the wood,
Call'd Jupiter's, t'th' caſtle Caria, ſtood
Two ſmall ſquare temples; to Nyctelius Bacchus
The one, the other t' Apoſtrophia Venus,
Were dedicated; and their pavements laid
With foot ſquare ſtones; but Venus' temple ſtray'd,
Each ſide thereof, exceeding Bacchus, lay
Full twelve foot farther; but theſe pavements gay
Contain two thouſand ſix ſcore ſtones: Pray tell,
Each in its ſep'rate length erected well.

II. *Question* 85, *by Mr.* Moyle.

'Twas in the pleaſant month of May,
The leaves were green, and flowers gay;
The winds lay ſtill, the air was clear,
Only one cloud there did appear;
Which I by obſervation found,
Twenty degrees above the ground.
In altitude bright Sol was then
Above the cloud degrees fifteen;
The ſhadow of the cloud, I found,
Did from my ſtation touch the ground,
In yards exact, as e'er cou'd be,
The ſame you in the margin ſee. [2304 *yards*]
This being known, to me declare,
The cloud's height perpendicular.

III. *Question* 86, *by Mr.* Joſ. Dogharty.

Three ſhips ſail'd from a certain port to ſea,
To different ports, whoſe latitudes agree;
Fifty-five leagues the firſt ſail'd, ſouth his coaſt.
Th' others to coaſts unknown, 'tween ſouth and weſt;
Till each arriv'd at his true deſtin'd poſt,
When they aſunder leagues fifty-ſeven were juſt:
Angle * thirty-eight made. Whence they begun, * *Degrees*
Pray tell me what the courſe, and diſtance run?

IV. *Question*

IV. *Question* 87, *by Mr.* T. Williams, *of Middleton-stoney.*

A friend did buy the other day,
Some land, a new unheard-of way;
I'th' latitude of fifty-two,
And by the method here below.
'Twas to be bounded by the shade
That, March the tenth, a tall tree made,
Betwixt the hours of eight and one;
Therefore triangular when done.
The topmost shade the base must show,
And by the bodies the sides you'll know.
One angle will be at the tree,
In height one hundred feet and three.
Now, sir, I've sent to you, for fear
The sun should not that day appear;
Pray shew the lengths and area clear.

V. *Question* 88, *by Mr.* Chris. Harris.

Suppose a polygon, of seven equal sides, were inclosed round about with shillings, each being an inch in the diameter; the shillings that reach round, just pays the purchase of what is inclos'd at this rate:

The shillings which do for one acre pay,
Are eleven times the number of acres: Pray
What number of acres inclosed must be,
And the price of each acre pray let us see?

VI. *Question* 89, *by* Adrastea, *who in it answers all the Enigmas in the last year's diary.*

In ancient times, when Minos kept his seat,
Of law and justice, in the isle of Crete;
Then curious arts in infant dress appear'd,
And none of sailcloth's mighty use had heard:
Mechanic skill, scarce *Mushroom* height could run, 91
Which *Winter* frost destroys, and *Summer* sun. 90
Till Dædalus, accus'd of murder, came,
Whose art affix'd a proverb to his name:
A labyrinth he form'd, more intricate
Than those wherein Newcastle *Coals* they get; 2d *Lat.*
In which himself and son were both confin'd,
When glorious *Reputation* fir'd his mind. 97
What hardships mortal men are born to feel,
No *Coach* turns half so fast as fortune's *wheel.* 1st *Lat.*
Discord began in Candy's court to reign, 94
An injur'd husband can't forgive the queen;

Nor

Nor thoſe were privy to her guilty love,
But Dæd'lus' arts muſt Dædulus remove.
Some *Plumes* he got, drawn from the grey *Gooſe* wing, 95
To make a curious preſent to the king.
Which pinion-wiſe, he fix'd unto his arms,
And ſwiftly flew from the impending harms:
Leaving Paſipha to bemoan her crime,
Or with her *Thimble*, to beguile her time. 93
While he in Cuma, to Apollo rais'd
A ſplendid temple, where the god was prais'd.
Had Icarus a ſheet of *Pins* employ'd, 90
When Sol's refulgent rays with wax he try'd,
His fate ſevere, perhaps had milder been,
And he once more, perhaps, his father ſeen.
But where do poets rove? His wings were ſails,
Which Boreas' *Bellows* fill'd with ſpeedy gales; 92
And when immur'd, as a ſuſpicious gueſt,
Himſelf and others by their aid releas'd.
Some malcontents, in number twenty-four,
With ſpecious promiſes his aid implore:
Tell him, the charges they'll with joy defray,
Name but the ſum, and they'll the money pay.
My coſt, ſays he, is all that I demand;
Twenty-four pounds, paid down, when next we land:
But as you different in your orders be,
I'll have you to this method all agree;
The captains each a certain ſum ſhall pay;
The captains' mates, each half as much as they;
The common ſailors, one-fourth part of that;
Half a ſailor's ſhare muſt be each boy's lot.
Now tell me, artiſts, how many there were
Of every ſort, and what was each one's ſhare?
For Cretans, fam'd for treachery and deceit,
Deny'd their promiſe, and ne'er paid the debt:
So after-ages may their ſums rehearſe,
Or ſing their numbers in heroic *Verſe*. *Prize.*

VII. *Queſtion* 90, *by Mr.* Deare.

A dying knight, in riches who abounds,
Leaves an eſtate worth fifty thouſand pounds:
This for two hopeful children he deſigns,
And that they thus divide it, them enjoins;
The elder ſon the greater ſhare muſt take;
Which being ſquar'd, the ſquare thereof will make
A number equal to the younger's ſhare,
When multiply'd into the pounds that are
In the eſtate. Their portions each declare.

VIII. *Queſtion*

VIII. *Queſtion* 91, *by Mr.* C. Maſon.

An elliptical acre of graſs there is given,
Whoſe length to its breadth is as nine is to ſeven;
How long is the tether, and how brought to paſs,
That a horſe fed no more than an acre of graſs?

The Prize Queſtion for 1721. *The gardens of Alcinous, from the ſeventh book of Homer's Odyſſes, tranſlated by Mr. Pope.*

Cloſe to the gates, a ſpacious garden lies,
From ſtorms defended, and inclement ſkies.
Four acres was th' allotted ſpace of ground;
Fenc'd with a green incloſure all around.
Tall thriving trees confeſs'd the fruitful mold,
And red'ning apples ripen here to gold.
Here the blue fig with luſcious juice o'erflows;
With deeper red the full pomegranate glows.
The branch here bends beneath the weighty pear;
And verdant olives flouriſh round the year.
The balmy ſpirit of the weſtern gale
Eternal, breathes on fruits untaught to fail.
Each dropping pear, a following pear ſupplies;
On apples, apples; figs on figs ariſe:
The ſame mild ſeaſon gives the blooms to blow,
The buds to harden, and the fruits to grow.
Here order'd vines, in equal ranks appear,
With all th' united labours of the year:
Some to unload the fertile branches run,
Some dry the black'ning cluſters in the ſun;
Others to tread the liquid harveſt, join.
The groaning preſſes foam with floods of wine.
Here are the vines in early flow'r deſcry'd,
Here grapes diſcolour'd, on the ſunny ſide,
And there in autumn's richeſt purple dy'd.
Beds of all various herbs, for ever green,
In beauteous order terminate the ſcene.
Two plenteous fountains the whole proſpect crown'd,
This thro' the gardens leads its ſtreams around,
Viſits the plants, and waters all the ground;
While that in pipes, beneath the palace flows,
And thence its current to the town beſtows:
To various uſe, their various ſtreams they bring,
The people one, and one ſupplies the king.

The

The king's pipe delivers the water ten foot and an half (Engliſh meaſure) below the ſurface of the water in the fountain, by an inch and three quarters bore: His brewing, once a week, takes fifty hogſheads of water, (wine meaſure) kitchen, landry, other offices, &c. five hogſheads a-day. The people have occaſion for twenty hogſheads a-day; their cock, of two inches diameter, is below the fountain twenty-two foot. His majeſty ſo much delights in a morning walk to ſee the waters undiſturbed, that his orders are, that the cocks ſhall but run once every day, and that in the evening; ſo long only, as may ſupply next day's conſumption, and for ſo much in his reſervoir, as ſupplies his brewing each week. Then if the velocity or motion of the water be equal to that of an heavy body, acquired in theſe deſcents; and alſo, it be premiſed, that heavy bodies accelerate as the ſquares of their times, as ſixteen foot the firſt ſecond it falls, &c. How long every day ought each pipe to run, to give the king and people their due quantity?

A Dissertation on Engines.

Amongst the many useful inventions, those engines that are mov'd by the wind, water, horses, &c. such as mills, water-works for towns, gins, and machines for draining of mines, are not the least valuable; tho' generally very inartificially perform'd, more especially the latter.

It were much to be wish'd, they who write on the mechanical part of the subject, would take some little pains to make themselves masters of the philosophical and mechanical laws of (motion or) nature; without which, it is morally impossible to proportion them so as to perform the desired end of such engines. We generally see, those who pretend to be engineers, have only guess'd, and the chance is, they sometimes succeed; else they have made them like others that have done pretty well. But he who has skill enough in geometry, to reduce the physico mechanical part to numbers, when the quantity of weight or motion is given, and the force designed to move it, can bring forth all the proportions, in a numerical calculation, so as it may be almost impossible to err.

For was I to raise a certain number of hogsheads of water in an hour, by a water-wheel, I must first find the quantity and velocity of my aquæduct, design'd for to fall on my wheel, from which I may proportion the diameter of my wheel; and such pumps, suckers, forcers, chains, or buckets; as that the force on my wheel may be so far superior to the weight of the columns of water to be raised, as it may be capable, by a certain number of revolutions in the hour, to fit my purpose, with due regard to the friction of the engine.

The following table I calculated in 1717, for a particular sort of engine; wrought by the pressure of the atmosphere, on the vacuum of an exhausted receiver; which is easily done 16 or 20 times a minute: the atmosphere pressing with a weight near 15 pounds avoirdupois, on every square inch contain'd in the surface of the piston or sucker, when the mercury stands at 29½ inches (a medium) in the barometer. The ale gallon of 282 cubic inches weighs of pure water 10 pound 2 ounces avoirdupois. But to allow for frictions, and for a considerable velocity, each inch of the vacuum, experience tells us, will raise but about 8 pounds of water.

A

A Physico Mechanical Calculation of the Power of an Engine.

Diam. of the pump.	Draws at a 6 foot stroke.	At 16 ft. in a min. draws per hour.		The diameter of the cylinder.	The depth to be drawn in yards.												
					15	20	25	30	35	40	45	50	60	70	80	90	100
Inches	Ale gall.	Hogsh.	Gall.		Inches.												
4	3·20	48	51						9	10	11	11½	12	13½	14	15	16
4½	4·04	60	60					10	11	11¾	12	13	14	15	16	17	18¼
5	5·02	66	61				10	11	11¾	13	13¾	14	15½	16¾	18½	19¼	20¼
5½	6·26	94	30			10	11	12	13	14	15	15¾	17	19	20	21	22¼
6	7·22	110	1		9½	11	12	13	14	15½	16	17	19	20½	22	23	24½
6½	8·46	128	54		10	12	13	14	15½	16¼	18	19	20	22	23	24½	26¼
7	9·82	149	40		10¾	13	14	15½	16¾	18¾	19	20½	22	24	25½	27	28½
7½	11·32	172	30		11	13¾	15	16½	18	19	20	21¼	23¼	25	27	28½	30¼
7¾	12·02	182	13		12	14	15½	17¼	18¾	19¾	21	22	24¼	26	28	29½	31½
8	12·82	195	22		12½	14½	16½	18½	19	20½	21½	23	25	27	29	30½	32½
8½	14·52	221	15		13½	15¼	17¼	19	20¼	21¾	23	24	26¾	28½	31	32½	35¼
9	16·24	247	7		14	16¼	18	20	21½	23	24¼	25	28	30½	33	35	36½
10	20·04	304	48		15½	18	20	22	23¾	25¼	27	28¾	31¼	33¾	36	38¼	40

The

1722.

The Author's Preface.

INtellectual complexions have no desire so strong as that of knowledge; nor is any knowledge unto man more certain than the mathematical sciences: A study both useful and applicable to almost all the affairs of human life. For what business or discourse can we enter upon wherein quantity, time, or magnitude has not an immediate concern? By these we ought to model our arguments, as we would desire they should be clear, intelligible, and bear the test of the world: a thing I have observ'd almost generally neglected.

It has long been a maxim with me, *That any discourse, relation, or arguments, about quantity or measure, which agrees not to numbers, is in itself evidently false.* And since nothing can so regulate our minds to think and speak demonstratively, as the mathematical sciences, it may sufficiently justify my endeavours to introduce some few of both sexes to the study of them.

Providence has wisely design'd, that the sciences and arts severally have their votaries; and in what condition of life soever, each have their desires and objects fitted to them, whence springs their content and happiness in each state: but we generally observe, above all others, how equal is the distribution of wit, most being content with their share; though few with fortune. Amongst the most knowing parts of mankind, knowledge is more highly preferable than riches and vast possessions, by how much it distinguishes us above the brutes; which fortune only puts into a good pasture. If we are fallen in a middle state between too great a load of cares in the world, and the depression of poverty, we may with Agar be content: And whilst we strive to excel each other in arts and sciences, let not others out-strip us in content and a good life; it shall then be satisfaction enough for me, if I'm in some measure serviceable to my country, in a study not unpleasant to myself.

Pro captu lectoris habent sua fata libelli.

Griff, Juxta Covent. decimo nono Augustij, 1721.

Intro-

Introduction and Corrections.

It was a rule laid down by my predeceſſor, that whoever ſent queſtions, enigmas, &c. ſhould give the ſolutions with them, and this experience ſhews me is very requiſite: for it may ſometimes ſo happen, that an enigma may be doubtful, or admit of more ſolutions than one, which utterly deſtroys the deſign. And as it ſeems very difficult in mathematical queſtions, where terms of art are to be preſerv'd, to write clear, intelligible, and in a ſmooth ſtile, confining one's ſelf to the jingle of words; it may not be wonder'd at, that ſome queſtions have not been ſo clearly expreſs'd as to meet with a true ſolution, ſuch as their authors deſign'd. It is on this account I have here corrected ſome faults in the anſwers laſt year, which are fully demonſtrated by Mr. *J. Jope*, jun.

Queſt. 75, *in diary* 1720. Put n for the time after Michaelmas 1719. Then $100 : 5 :: 320 : 16$ and $1 : 16 :: n : 16n$, the intereſt of 320 *l.* Then $320 + 16n =$ the amount of 320 *l.* $5 - n =$ the time the 202 *l.* was received before due. $1 : 5 :: 5 - n : 25 - 5n$ and $125 - 5n : 100 :: 202 : \frac{20200}{125 - 5n}$ = value 202 *l.* at the day of payment. Then by the queſtion $16n + \frac{20200}{125 - 5n} = 202$, which by reduction gives $n = 1{\cdot}760076$ = 1 year 277 days 10 hours. So that the day of payment ſhould be July 4th, 1721.

Paradoxes anſwered.

Par. 1 *anſwer'd.* In any deep well or coal-pit, from the bottom, if the ſhaft be ſtreight, and there happen to be ſtars of any conſiderable magnitude in or near the zenith, you'll by a minute or two ſtedfaſt looking up diſcover them. Some aſtronomers have wells for that purpoſe.

Par. 2 *anſwer'd.* In ſeveral places where the water for ſome ſpace runs under ground; as the river Guiadiana in Spain. But our own country of Warwick has ſuch a bridge.

The river Ichene, from a Saxon word, to ſearch or penenetrate, is denominated the pariſh of Long Ichington. On a common near Over Ichington is a pool whoſe ſtream entereth the ground, and after an intricate paſſage of half a mile, cometh ont again and paſſeth along the brook. And Icheham near Windſor has its appellation from ſuch a paſſage.

Par. 3 *anſwer'd.* The prime meridian, from whence longitude is accounted both ways, paſſes through the middle betwixt the ſhip and iſland, and ſo regard is had to the eaſt and weſt longitude, and not to the points of the compaſs.

Par. 4 *anſwer'd.* The perſon was born in leap year, Feb. 29.

Queſtions anſwer'd.

* I. *The* 84*th queſtion anſwer'd by Mr.* Cha. Glover.

Let $a =$ the greater ſide, $e =$ leſſer. There's given the difference of the ſides d, and the ſum of their ſquares z; which by involution, ſubtraction, and evolution, this equation is found,

$a = \frac{d + \sqrt{2z - dd}}{2}$; ſo $a = 38$, $e = 26$ the ſolution.

† II. *Queſtion* 85 *anſwer'd.*

The cloud's height is 1747 yards by the prop. By ſome tables and rules it is 1744·8; but taking no notice of the ☉'s alt. at the different places, 'tis 1746·3.

III. *Queſtion*

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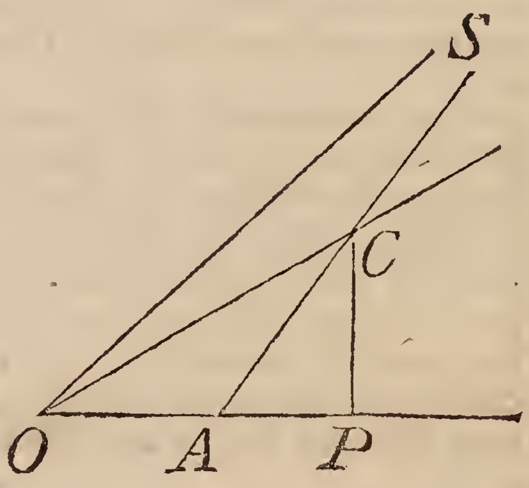
* I. QUESTION 84.

Put $z =$ the half ſum of the two numbers, $d = 6$ the half difference, and $s = 2120$ the ſum of their ſquares. Then $z + d$ and $z - d =$ the two numbers; the ſum of whoſe ſquares is $2zz + 2dd = s$. Hence $z = \sqrt{\frac{1}{2}s - dd} = \sqrt{1060 - 36} = 32$; and therefore 38 and 26 the two numbers.

† II. QUESTION 85.

Let S be the ſun, C the cloud, and O the obſerver, all in the ſame vertical plane; upon the horizon OP let fall the perpendicular CP the height of the cloud; draw SC, and produce it to cut the horizon in A the ſhadow of the cloud. Then OA will be given $= 2304$ yards, the angle $AOC = 20°$; and if the elevation CAP of the ſun at A be



* III. *Question* 86 *answer'd by Mr.* John Jope, *jun. of Loo, in Cornwall.*

$x^4 + 2ax^3 + a^2 + 2b^2x^2 + 2ab^2x = \frac{a^2b^2R^2}{c^2} - a^2b^2 - b^4$. Where x is found $= 15{\cdot}103$: whence the course is S. 15° 21′ W. and the distance $= 57{\cdot}035$ leagues. The other course is S. 53° 21′ W. and the distance 92·139 leagues.

A full and compleat algebraic solution, by Mr. *Andrew*, room will not admit.

IV. *Question*

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be supposed = the elevation SOP at O, then the angle $CAP = 35°$, the $\angle OAC = 145°$, and $\angle OCA = 15°$.——Hence, As s. $\angle ACO : OA ::$ s. $\angle AOC : AC = \frac{\text{s. } 20°}{\text{s. } 15°} \times AO$; and, in the triangle APC, as 1 (rad.) : s. $\angle CAP :: AC : CP = \frac{\text{s. } 20° \times \text{s. } 35°}{\text{s. } 15°} \times AO = 1746{\cdot}34$ yards, or near a mile for the height of the cloud.

But as 2304 are rather above 1 minute of a degree of a great circle, the $\angle CAP$ will be about 35° 1′, and then $CP = \frac{\text{s. } 20° \times \text{s. } 35° 1'}{\text{s. } 15° 1'} \times AO = 1745{\cdot}17$ yards the distance, a little less than before.

* III. QUESTION 86.

The meaning of this question is, that three ships sail from a port to three other ports in the same parallel of latitude; the one of them sails direct south a given distance, the other two between the south and west, the differences of their courses being given, and the distance between their two ports. Or, in other words, Given the base, the perpendicular, and the vertical angle of a triangle, to find the rest.

Let C, P, A, O (see the last fig.) be the four ports; then $CP = 55$ leagues, $AO = 57$ leagues, and $\angle ACO = 38°$. Now, by prop. 13 Simpson's Trigon. As 1 : cot. $\frac{1}{2} \angle ACO ::$ $2AO \times CP : \overline{OC + CA}|^2 - AO^2$; hence $OC + CA = \sqrt{AO^2 + 2AO \times CP \times \text{cot.} \frac{1}{2} \angle ACO} = \sqrt{57^2 + 57 \times 110 \times \text{cot. } 19°} = 146{\cdot}487$ the sum of the sides. And, by prop. 14 of the same, 1 : tan. $\frac{1}{2} \angle ACO :: 2AO \times CP : AO^2 - \overline{OC - CA}|^2$; and hence $OC - CA = \sqrt{AO^2 - 2AO \times CP \times \text{tan.} \frac{1}{2} \angle ACO} = \sqrt{57^2 - 57 \times 110 \times \text{tan. } 19°} = 33{\cdot}016$ the difference of the sides. Then, the half sum increased and diminished by the half difference, we

* IV. *Question 87 answer'd.*

	hours	☉'s alt.	azim.	leng. shade	
The 10th March.	VIII	17° 36′	65° 32′	318·2	Feet.
Latitude 52.	IX	25 48	51 45	212·9	
	X	32 13	36 14	163·4	
	XI	36 29	18 47	139·23	
	XII	38 0	0 0	131·83	
	I	36 29	18 47	139·23	

The figure will be triangular, the shadow at 8 and 1, being two of its sides, and right lines; the third (the path of the nodus or top of the tree) a curve line, of the conic sections, about 334 foot. The content 22200 square feet = 2 ro. 1 per. and 148 square feet. Those who have taken the horizontal distances with respect to the pole, instead of the azimuths, have given false solutions.

This

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we have 89·7515 and 56·7355 for the two distances *CO* and *CA*. Again, as 146·487 (sum of sides) : 33·016 (diff. sides) : : cot. 19° ($\frac{1}{2}\angle OCA$) : tan. 33° 12′ = half the difference between the angles *A* and *O*; and from the half sum and difference those angles are found = 104° 12′ and 37° 48′ the complements of 14° 12′ and 52° 12′ the two courses required.

It is evident that this problem will be constructed, by describing on the given base *AO* a segment of a circle to contain the given vertical angle; and then a line drawn parallel to the base at the distance of the perpendicular from it, will cut the circle in the vertex of the triangle.

* IV. QUESTION 87.

The piece of land in this question is a triangle on the horizontal plane, of which two sides are the shadows of the tree at 8 and 1 o'clock, and the third side the line described by the shadow of the top of the tree between the same two hours; and this third line will be right as well as the two former, and not a conic section, because the sun is in the equinoctial, it being the 10th of March old stile. The said third line will also be directly east-and-west, or perpendicular to the meridian or shadow of the tree at 12 o'clock.

Now

This question may be wrought thus:

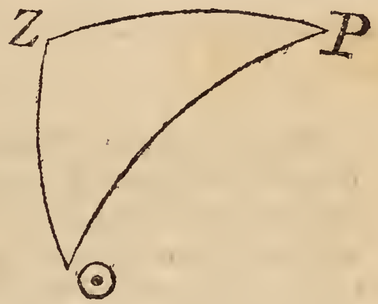
As rad. — —	90°	0′
To cosine lat.	52	0
So is cosine of the hour	60	0
To sine of the altitude	17	56

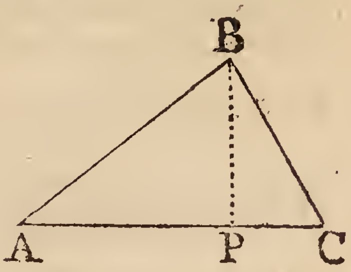
As cotang. lat.	52°	0′	9·89280
To radius — — —			10·00000
So tang. altit.	17	56	9·51005
To sine azimuth	65	32	9·61724

As sine 17° 56′ : log. 103 :: sine 72° 4′ : log. 318, and so for the rest. And you'll have several triangles with 2 sides and an angle between them given, to find their contents; which in one sum gives the area of the whole more exact than by taking it as one single triangle, by reason of the curve line in each of them.

V. *The*

Now, if P represent the pole, Z the zenith, and ☉ the sun at any hour: Then are given PZ the co-latitude, P☉ a quadrant, and $\angle P =$ the hour from 12; to find the $\angle PZ$☉, the sun's azimuth or bearing at that hour. And, taking the extreme hours 8 and 1 in the question, their azimuths will come out 65° 32′, and 18° 47′; which are the two angles ABP, CBP, contained by the meridian shadow BP, and the two extreme shadows BA, BC, the place of the tree being at B. Now, the sum of these two angles is 84° 19′ = the $\angle ABC$, and their complements are 24° 28′ and 71° 13′ = the angles A and C. So that all the angles are then known.





Again, the meridian altitude of the sun being 38° = the complement of the latitude 52°, we shall have as 1 : tang. 52° :: 103 feet (the height of the tree) : 131·834 = BP the length of the meridian shadow. From hence, and the given angles, AP and PC are easily found = 289·73 and 44·837, and then the area = 22053·65 square feet = 2·0218 roods.

* V. *The 88th Question answer'd by Mr.* L. Evan.

If 3·633959 be the area of a heptagon, whofe fide is 1; then put $x =$ the acres, $11x =$ fhillings, the price of 1 acre. $1 : 11x :: x : 11xx =$ the price in fhillings of all the acres bought = inches round the polygon; 6272640 inches = 1 acre.

$$3{\cdot}633959 : 1 :: 6272640x : \frac{6272640x}{3{\cdot}633959} = \text{fquare each fide.}$$

7 times the fquare root of that $= 11xx$. That is $\sqrt{\frac{6272740x}{3{\cdot}633}}$ $= \frac{11xx}{7}$, or $\frac{6272640x}{3{\cdot}6339} = \frac{121x^4}{49}$, or $\frac{307359360x}{3{\cdot}633959} = 121x^4$; hence $307359360x = 439{\cdot}709039x^4$, and $699006{\cdot}235 = xxx$. Then $88{\cdot}74999 = 88$ ac. 2 ro. 39 per. $= x$ the number of acres bought. 976·24989 fhill. = 48 *l.* 16 *s.* = the price of 1 acre.

VI. The 89th, or *Adrafted*'s queftion, by the omiffion of a line or two to limit it, admits of many anfwers.

For when the number of quantities fought exceeds the number of given equations, the queftion is capable of innumerable anfwers.†

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* V. QUESTION 88.

Since the price of one acre in fhillings is equal to 11 times the number of acres, it is plain that the price of all the acres will be 11 times the fquare of the number of acres; but the price of the whole is equal to the circumference in inches, therefore the circumference in inches is equal to 11 times the fquare of the acres.

Now if x denote the fide of the heptagon in inches, $a = 3{\cdot}633912$ the area of a heptagon whofe fide is 1, and $b = 6272640$ the inches in an acre. Then $7x$ will be the perimeter, and $\frac{ax^2}{b}$ the acres; wherefore $7x = \frac{11a^2x^4}{b^2}$; hence $x = \sqrt[3]{\frac{7bb}{11aa}} = 12377{\cdot}1 =$ the fide. Then $\frac{ax^2}{b} = 88{\cdot}7487$ the number of acres.

† VI. QUESTION 89.

In the above original anfwer, it is juftly remarked that the *data* are infufficient; for, to have limited the anfwers, there ought to have been three more conditions; fo if three of the numbers of perfons had been given, the queftion would have been confined to one anfwer, and the method of folution too eafy to need any pointing out here.

$$24\left\{\begin{array}{llll} 2 \text{ captains} & 4\,l. \text{ each} & = 8\,l. \\ 4 \text{ mates} & 2 & = 8 \\ 14 \text{ sailors} & 10\,s. & = 7 \\ 4 \text{ boys} & 5 & = 1 \end{array}\right\}\begin{array}{c} l. \\ 24 \end{array}$$

Mr. *Evan* has collected 100 true anſwers, which for brevity I omit.

* VII. *The 90th Queſtion anſwer'd by Mr.* Cha. Glover.

Let $a =$ eldeſt ſon's portion, $e =$ youngeſt, $aa = se$, and $s - a = e$ per queſt. this equation is produced,

$a = \sqrt{ss + \frac{1}{4}ss} - \frac{1}{2}s$. $a = 30901{\cdot}69943746$ or $30901\,l.\ 14\,s.$ $e = 19098{\cdot}30056251$ or $19098\,l.\ 6\,s.$

† VIII. *The 91ſt Queſtion anſwer'd by Mr.* J. Andrew.

The tranſverſe diameter 16·184053 perches = 89·01 yards.

The conjugate diameter 12·587597 perches = 69·23 yards. Diſtance between the focus points 55·9463; thence to the extreme parts 44·505, doubled 89·01 added to the diſtance between the foci is the length of the tether 145 yards.

The

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* VII. QUESTION 90.

In this queſtion are to be found two numbers, of which the ſum is given, and the ſquare of the greater equal to the leſs multiplied by the given ſum. Or, it is required to divide a given number into two ſuch parts, that thoſe parts and the whole may be three numbers in geometrical progreſſion. Or, in other words again, to divide a given number according to extreme and mean proportion; which it is well known will not admit of an anſwer in integer numbers.

Put $s = 50000$ the ſum, and x the greater part. Then $s - x =$ the leſs, and $xx = ss - sx$; hence $x = \frac{\sqrt{5} - 1}{2} \times s = 30901{\cdot}6994375$, and conſequently the other part $= 19098{\cdot}3005625$, as above determined.

† VIII. QUESTION 91.

Put $9x$ and $7x$ for the two axes in yards. Then $63xx \times {\cdot}785398$ &c. $= 4840$ the ſquare yards in an acre. Hence $x = \sqrt{\frac{4840}{63 \times {\cdot}7854}} = 9{\cdot}890255$; conſequently $9x$ and $7x$ become $89{\cdot}0123$ and $69{\cdot}2318$ for the two axes. Then $89{\cdot}0123 + \sqrt{89{\cdot}0123^2 - 69{\cdot}2318^2} = 144{\cdot}96 =$ length of the tether.

The way for the horſe to graze juſt an elliptical acre, is thus: Set up two ſtakes or pins in the longeſt diameter of the oval, 16 yards 6 inches and a quarter from the outſide. Put a ſtring of 145 yards long round both ſtakes, and tie the two ends together; at which knot let the horſe's mouth be fix'd: then in going about he will exactly ſweep the oval, containing 4840 ſquare yards, or one acre.

* *The Prize Queſtion anſwer'd.*

In anſwering this queſtion in hydroſtatics, the philoſophy of the gravity and preſſure of fluids is to be conſider'd: That at the firſt moment the cock or adjutage is open'd, the liquid flows out with the ſame velocity as a heavy body moves when fell from that height the liquor came, or the place of the reſervoir. The water that enters the top or mouth of the pipe, moves as faſt as that flowing out, at what depth

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* PRIZE QUESTION.

Put $a =$ the altitude of the ſurface of the water above the delivering pipe, $n =$ the area of the orifice or pipe, and $m = 32\frac{1}{6}$ feet $= 386$ inches. Then proceeding as in page 4 of our new Math. Miſcel. $\sqrt{2ma}$ will be the velocity of the iſſuing water, upon the ſuppoſition of the queſtion, that it is equal to that of a heavy body after falling through the ſpace a; but if, according to Sir I. Newton and ſome others, the velocity be that which is acquired by falling through only $\frac{1}{2}a$, it will be $\sqrt{ma}$; which is to the former as 1 to $\sqrt{2}$, and therefore the time for the one ſuppoſition may be found from that of the other, by this proportion of 1 to $\sqrt{2}$.

Now in the former caſe with the velocity $\sqrt{2ma}$ per ſecond, we ſhall have $n\sqrt{2ma}$ for the quantity run out per ſecond; and therefore $n\sqrt{2ma} : Q :: 1$ ſecond $: \frac{Q}{n\sqrt{2ma}} =$ the ſeconds in which the quantity Q will be voided.

Then, for the king, $Q = 12\frac{1}{7}$ hogſheads $= 12\frac{1}{7} \times 63 \times 231$ or 176715 cubic inches, $n = 1{\cdot}75^2 \times {\cdot}7854$, and $a = 10\frac{1}{2}$ feet $= 126$ inches; with which numbers $\frac{Q}{n\sqrt{2ma}}$ becomes $235{\cdot}565$ ſeconds, or 3 min. $55\frac{1}{2}$ ſec.

And, for the people, $Q = 20$ hogſheads $= 291060$ inches, $n = 2^2 \times {\cdot}7854 = 3{\cdot}1416$, and $a = 22$ feet $= 264$ inches; which numbers give $205{\cdot}22$ ſeconds $= 3$ min. $25\frac{1}{4}$ ſeconds; both nearly as in the original anſwer.

But if the other ſuppoſition be uſed, of $\sqrt{ma}$ velocity per ſecond; then each of the above times muſt be multiplied by $\sqrt{2}$.

depth ſoever, in an equal cylinder. Whereas a heavy body moves ſlow at firſt ſetting out, and continually receives a new impulſe of gravity, which when it has fallen the length of the water-pipe, is equal in velocity to that column of water. Then as a body accelerates with the odd numbers 1, 3, 5, &c. the water going out as faſt the firſt ſpace, as a weight falls in the ſecond; conſequently muſt be as Graveſand, in his Mathematical Philoſophy, page 188, N° 378, ſays,

"In the time in which a body falling freely, goes through "the height of the liquid above the hole, a column of the "liquid flows out equal in length to twice that height."

On this principle was the queſtion compoſed, having Graveſand then before me; which is plain from the queſtion itſelf, the word [acquired] meaning no other, than that the water moved as faſt as the body, when it had fallen the height of that liquid: But the deſign of putting it in thoſe words was to prevent ſuch who had not ſkill enough in philoſophy, ſtamping a ſolution to it.

The king uſed 765 gall. $= 12\frac{1}{7}$ hogſheads per day. The bore 1·75 inch ſquared × by 252 double height ÷ 294·12 gives 2·6579 w. g.) 765 (287·9 times (the height) for the quantity. □ 60‴ = 3600) 192 (·05333 inch, the ſpace accelerated in 1 third. Then $10\frac{1}{2}$ feet = 126 inches — ·05333 gives 48·621 thirds multiplied by 287·9 is 13994·819 thirds = 3′ 53″ 14‴. *The anſwer.*

The people uſe 1260 gallons per day.

Height dupla 528 × 4 dia. ſq. ÷ 294·12 = 7·18 w. g.

1260 ÷ 7·18 = 175·49 ſuch columns $\sqrt{\frac{22}{16}} = 1{\cdot}17 \times$ 175·49 = 205·3233 = 3′ 25″ 32‴. *The anſwer.*

Of the Eclipſes in 1722.

In the annual revolution of that glorious body the ſun, three times will the dark body of the moon interpoſe and eclipſe its light from us; and twice will the earth interpoſe between the ſun and moon, and deprive her of a borrow'd light.

1. Sun eclipſed, Saturday the 6th of January, 6 min. after 11 o'clock in the morning, but not viſible to us in England: the moon's latitude cauſing the ſhadow to fall in the more ſouthern countries.

2. Sun eclipsed, Saturday the 2d of June, 40 min. after 7 in the evening, but invisible.

3. Moon eclipsed, total and visible, on Monday the 18th of June, at 2 in the morning.*

	Beginn. h. m. s.	Middle h. m. s.	End h. m. s.	Digits h. m. s.
Adrastea's calcul. Coventry	0 3 41	1 40 20	3 17 0	13 39 40
Coventry by Chattock	0 3 43	1 40 27	3 17 11	13 42 5
Astronomia Britan. London	0 13 51	1 54 31	3 35 11	14 13 49
London by Silvia	0 13 32		3 27 20	13 15 0
Lond. Flamst. Table Gibbon	0 13 16	1 51 33	3 29 50	13 56 2
London by Leadbetter	0 19 50	1 56 37	3 33 24	13 32 0

4. Sun

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* This eclipse of the 18th of June was observed

1. At *Greenwich* by Dr. *Halley* thus.

App. Time. h.	m.	
13	12	Between these two times the eclipse became total.
13	29	
15	26	Between these times the end.
15	27	

2. At *Port Royal* in *Jamaica* by Capt. Candler.

h.	m.	s.	
6	59	10	The eclipse began.
8	7	50	Immersion.
9	11	0	Emersion.
10	19	40	The end.
8	39	25	Whence the middle.

So that the diff. of long. between Port Royal and Greenwich will be 5 h. 6 m. 50 s. or 5 h. $6\frac{1}{2}$m. from London; that is, 76° $37\frac{1}{2}'$.

3. At *Berlin* by Mr. *Christifried Kirck*.

h.	m.	s.	
12	59	55	Beginning.
14	8	8	Immersion.

Berlin is 54 m. of time, or 13° 30′ of long. east of London.

4. Sun eclipſed, viſible, Tueſday the 27th of November, 50 minutes paſt 2 in the afternoon.*

	Begins	Middle	End	Digits
	h. m. s.	h. m. s.	h. m. s.	d. m. s.
By Aſtronomia Carolina at Coventry	I 43 31	II 47 53	III 48 20	5 15 31
Scientia Stell. Coventry	I 31 42	2 41 23	3 47 10	6 3 56
Leadbetter, London	I 50 52	2 58 17	4 1 20	5 47 0

5. Moon eclipſed, viſible, Tueſday the 11th of December, 21 minutes paſt 3 in the afternoon.

	h.	m.
The beginning at	II	7
Greateſt obſcuration	III	21
The end — —	IIII	34
Whole duration —	2	27
Digits eclipſed —	5	29

New

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* This eclipſe of the 27th of November was obſerved thus.

1. At *Greenwich* by Dr. *Halley*.

Tempora.

h.	m.	s.	
1	29	16	Eclipſin jam inceptam vidi.
3	43	25	Finis eclipſeos dubius, ob limbum ſolis aſperum & undulantem nec ſat bene definitum.
3	43	45	Certe defierat eclipſis.

2. *At London* by Mr. *G. Graham.*

App. Time.

h.	m.	s.	
1	28	38	Beginning.
3	43	22	End
2	14	44	Duration.
5·716 dig.			Quantity eclipſed.

3. At *Wakefield* in *Yorkſhire* by Mr. *Hawkins*.

h.	m.	s.	
1	21	0	Beginning.
3	30	3	End

The ſun's diameter obſcured ſomewhat more than 5 digits.

4. At *Cambridge* in *New England* by Mr. *T. Robie.*

h.	m.	s.	
9	25	45	The end of the eclipſe.

Mr. *Owen Harris*, an ingenious Schoolmaſter in *Boſton*, ſays he obſerved the end at about 9 h. 26 m.

U 2

New Paradoxes.

Par. 1. There are divers remarkable places upon the terraqueous globe, whoſe ſenſible horizon is commonly fair and ſerene; and yet 'tis impoſſible to diſtinguiſh properly in it any one of the intermediate points of the compaſs; nay, not ſo much as two of the four cardinals themſelves.

Par. 2. There are three diſtinct places of the earth, all differing both in longitude and latitude, and diſtant from one another two thouſand miles compleatly; and yet do all bear upon one and the ſame point of the compaſs.

Par. 3. There are three diſtinct places on the continent of Europe, lying under the ſame meridian; and at ſuch a diſtance, that the latitude of the third ſurpaſſeth that of the ſecond, by ſo many degrees and minutes exactly, as the ſecond ſurpaſſeth the firſt; and yet the true diſtance of the firſt and third from the ſecond (or intermediate place) is not the ſame by a great many miles.

New Queſtions.

I. *Queſtion* 92, *by Mr.* J. Andrew.

How much to mathematic art is due,
None truly know but thoſe that it purſue:
The lofty paths trac'd by great Newton's hand,
Or thoſe whoſe works like his will ever ſtand,
Long as Ægyptian piles, but yet more bright,
And to ſucceeding ages give a pleaſing ſight.
Gen'rous Halley, ne'er equall'd yet we knew;
Great Britain's ſons will long his numbers view;
Their wond'rous works with admiration tell,
What pains they took, and how they did excel.
You ladies, who in numbers' ſports are known,
Let's know the greateſt fruſtum of a cone,
(In ale gallons) in a ſemi-ſpheroid,
Tranſverſe thirty, and twenty inches wide.

II. *Queſtion* 93, *by Mr.* C. Maſon.

Seen, June the ninth, a lofty tower to be,
In height two hundred fifty foot and three.
Upon its top a veering fane, but I
At that ſame time could not its height deſcry:

The

The sun then shone, I did the shadow take
The tower and fane did both together make;
Whose length I found the height o'th' tower to be;
Its bearing north north-west appear'd to me.
In latitude, degrees just fifty-four;
The height describe; the fane's above the tower.

III. *Question* 94, *by Mr.* Richard Whitehead.

I by an ancient writing understand,
My grandfather inclos'd a piece of land
With three brick walls, and then a garden made;
Green were the walks, and cooling was the shade:
A circling hedge of yew in which he plac'd,
And artful knots of flowers the circle grac'd,
Each wall was touch'd, by whose periphery
In the south wall you might a door-place see,
Just at its point of contact: Thus 'was cut
Into two segments, as in margin put. $39\frac{1}{2}$, $30\frac{1}{2}$ *yards.*
From corner opposite to that same wall,
A perpendicular's suppos'd to fall;
Its segment's product then in yards will be, $1181\frac{3071}{9600}$.
I pray, ye ladies fair, declare to me
The garden's true content, length of each wall,
Circle's diameter, as they do fall?

IV. *Question* 95, *by Mr.* Alex. Naughley.

As I happen'd once with a gauger to drink,
Who, proud of his art, would venture his chink,
That by right *data* he'd find to a gill,
Any tun's content in malt, wine, or ale.
Good luck it was then, a maltster was there,
Put on by the host, laid a wager of beer.
The dimensions given here you may see,
Of his own by-tub, he could not tell me,
What bushels it held, to a nicety.
The lesser diam. was inches thirty-two,
Segments, by cutting the diagonals, two,
Were twenty and thirty, appeared to view.
Then the gauger, incensed, wrought with his pen,
Cane, tape, rule, and tables; but all was in vain:
So, ladies, your aid he begs for this bout,
That the tale of a tub turn him not out.

V. *Question* 95, *by Mr.* Joſeph Smith.

Near to the borders of the German main,
There lies a piece of land, an even plane,
In form triangular, but not right:
The fences of the land lie very ſtreight;
The ſum of the ſides make twice forty-eight.
The third part of the longeſt fence, I know,
Is juſt the diff'rence of the other two;
And two chains leſſer than the ſhorteſt fence,
Makes true the baſe's ſegment's difference.
Three men they bought this land the other day,
And I muſt part it for them, as they ſay,
By art, and in a new unheard-of way.
In this ſame ground, a certain point there lies,
That if the field was hung, would poize
It equally above our earthly ball,
That neither ſide would riſe, nor neither fall:
To this ſame point, their fences I muſt bring
From the three angles, by a chain or ſtring;
The length o'th' fences of each ſev'ral part,
I do require, of all you ſons of art.

VI. *Question* 97, *by Mr.* R. Tapper.

An only ſon I am; my age I fain would know;
But the regiſters my age they cannot ſhow:
Yet all this I do remember very well,
Which makes me think my age you'll quickly tell.
If to double my age, you place the ſquare root,
Of my age doubled, with five years more to boot;
Square the laſt ſum, and add it to the other,
The aggregate of all thoſe ſums make together
Twenty-two hundred and ſixty, leſs by four:
My age to me, quickly pray declare. 16 *Jan.*
And canon true, to find it out this year. $172\frac{1}{2}$.

VII. *Question* 98, *by Mr.* T. Raſberry.

Three ſiſters jointly do agree
To venture portions in ſouth ſea;
But fickle fortune prov'd ſo croſs,
That each of them ſuſtain'd a loſs:
The diff'rence of their loſſes be,
A, two thouſand more than B,
And nine thouſand more than C.
But one thing more I will declare,
Of the eldeſt ſiſter's loſs, the ſquare
Is equal t'th' ſquares o'th' other two.
Each lady's loſs pray tell me true.

The

The Prize Queſtion, by Adraſtea; *the anſwerer may by lot win* 10 *of theſe diaries.*

Aſpire my genius! help my rhiming muſe,
In themes I in my native country chuſe:
Whilſt others plow the waves and tread the ſtrands
Of diſtant oceans, and of foreign lands;
To fill the mouth of fame with ſomewhat new,
(No matter 'tis how much of it be true).
From alps or mountains, ſtories ſtrange they bring,
Of deſert caves, or horrid monſters ſing.
Tell how Veſuvius' ſulph'rous darts do fly,
Or Ætna's ſmoke obſcure the azure ſky;
Or magnify the hazards they have run,
Scylla's and Charybdis's pointed rocks to ſhun.
Such tales we take in truſt from thoſe who rove,
Tho' none give rules by which the truth to prove.
But this by numbers may explained be,
By thoſe who never did the cavern ſee:
In Derbyſhire, a wonder of the Peake
Is Eldon-hole, as poets often ſpeak;
Whoſe depth exactly, none cou'd e'er deſcry,
Tho' atheiſt Hobbs his utmoſt ſkill did try,
Who wrote De Mirabilibus Pecci.
And burleſque Cotton does ſtrange tales rehearſe,
In ruſtic words, and hudibraſtic verſe,
How he this monſtrous orifice did plumb,
But cou'd not at the bottom of it come,
With ſixteen hundred yards of rope let looſe;
And tells a ſtory of a woman's gooſe:
Fabulous the one, ſo may the other be,
Erroneous too, without philoſophy;
Extenſion of the rope might him deceive,
And ſmall proportion which the plumb wou'd have
To ſuch a length; and part in water drown'd,
When in this vaſt abyſs within the ground.
But I the depth have found, exactly true,
By gravity; a method ſomething new.
As heavy bodies do accelerate,
In ſpaces known firſt to our Newton great.
Four pond'rous ſtones into the well let fall
In meaſur'd time, agreed in numbers all;
A pendulum, ſixty-one inches long,
By which the time I meaſur'd (was not wrong)
Vibrated freely, whilſt that each ſtone fell
Eight times; by which the depth I'd have you tell.
Allowing rightly for th' approach of ſound,
That your own works may not themſelves confound.

A

A farther Dissertation on the Engine, continued from the last Diary.

The last diary gave you the calculation of an engine wrought by the pressure of the atmosphere; what materials were capable of raising any quantity of water, not exceeding 300 hogsheads an hour, at any depth under 100 yards. The general use it has deservedly obtained in mines, makes it needless to say any thing more of its service: A philosophical and mechanical description of the machine, is too large for my room here; I shall at present only observe, that the boiling water in a close vessel, has an expansion and elasticity in steam, almost incredible. One cubic inch of water will produce or fill 13300 cubic inches with steam, each with an elasticity to raise a pound avoirdupois, in the common way of working such engines. But each inch may be made to raise 10 or 20 atmospheres, viz. 756 tun: A thing not hitherto taken notice of.

I have been led, through curiosity, many years to observe most engines of any account for service; and to peruse all books of engines I could in any language; but 'tis very strange, to find none of them shou'd write in such a practicable method, as might inform or teach others, nor understand mechanics and numbers.

Enough either to guide them towards truth, or skreen them from gross errors, when they give us a neat cut of an engine, turn'd by a current of water, or by wind or horses; and then tell us a romantic story, how the same may be wrought by a man or two men. One would think they never knew that the service of one horse equall'd the strength of five or six men; or that an overshoot wheel will exceed the strength of five or six and twenty horses, when suitably apply'd. They generally perplex the motions, one number giving power or velocity, and the next destroying it; making the friction great, and the working parts ill and unserviceable.

Engines are only valuable, as they carry a mathematical demonstration of their power and certainty. And could engineers consider that maxim, *What's gained in force, is lost in time; and what's got in time, is lost in force;* and Sir Isaac Newton's three laws of motion or nature; men would never entertain such ridiculous whims as perpetual motions, or pretend to do more than is possible, unless the Creator alter the whole fabric of nature.

Paradoxes

1723.

Paradoxes anſwered.

1 *Par. anſw.* UNDER either of the poles.

2 *Par. anſw.* All places differ in both longitude and latitude, at what diſtance ſoever, with reſpect to either poles bear upon the ſame point of the compaſs. Or they may be in the ſame ſpiral rumb; elſe underſtood as in the earth, and not upon it.

3 *Par. anſw.* The oblate ſpheroidal figure of the earth will cauſe ſuch a difference.

Queſtions anſwer'd.

* I. *Mr.* C. Maſon'*s anſwer to the 92d queſtion.*

Accept, fair nymphs, this free-will offering,
Which I with rev'rance to your altar bring;
Tho' my poor mite ye need not, nor my praiſe,
For your own works will laſting trophies raiſe;
But gratefully acknowledge that I owe
The art to you, which theſe ſolutions ſhow.

Let

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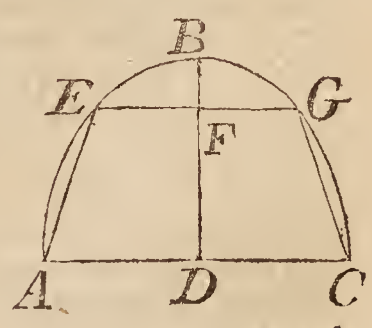
* I. QUESTION 92.

To find the greateſt fruſtum $AEGC$ of a cone that can be inſcribed in a given ſemi-ſpheroid ABC, the baſe of the cone being the ſame as that of the ſpheroid, whether it be oblate or oblong, that is whether the revolving axe AC be the leſs or the greater axe of the ellipſe.



Put $r = AD$ the ſemi-revolving axe, $f = DB$ the ſemi-fixed axe, and $x = DF$ the altitude of the fruſtum. Then,

by

Let the ſemi-tranſverſe 15 $= h$, and ſemi-conjugate 10 $= c$, length of the frumſtum $= a$, the difference put $= h - a$, and the ſemi-head diameter $= e$. Then,

$hh : cc :: hh - aa : \frac{hhcc - ccaa}{hh} = ee$. Which reduced gives $a = 10{\cdot}606601$, and $e = 7{\cdot}075$, and $2e =$ leſs diameter $= 14{\cdot}15$ inches; hence the content in ale gallons 8·6915.

Mr.

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by the ellipſe, $ff : rr :: ff - xx : EF^2 = \frac{ff - xx}{ff} \times rr$; hence the ſolidity of the fruſtum will be $\overline{rr + rr\sqrt{\frac{ff - xx}{ff}} + rr \times \frac{ff - xx}{ff}} \times \frac{3{\cdot}1416x}{3}$, and therefore $x \times \overline{1 + \sqrt{\frac{ff - xx}{ff}} + \frac{ff - xx}{ff}} =$ a maximum.——Or, put $zz = \frac{ff - xx}{ff}$, then $xx = ff \times \overline{1 - zz}$, and the maximum $= \sqrt{1 - zz} \times \overline{1 + z + zz}$; which put into fluxions and reduced, we have the equation $1 + z - 2z^2 - 3z^3 = 0$; whoſe root z is $= {\cdot}6464881$ very exact. Hence $z = \sqrt{1 - zz} \times f = {\cdot}762924f$, and the content of the greateſt fruſtum $= {\cdot}762924frr \times \frac{3{\cdot}1416}{3} \times \overline{1 + z + zz} = 1{\cdot}649344frr$.

Now in the caſe of the oblong ſpheroid, $f = 15$, $r = 10$, x the height $= {\cdot}762924f = 11{\cdot}44386$, and the content $1{\cdot}649344frr = 2474{\cdot}016$ inches $= 8{\cdot}773$ ale gallons.

But if the ſpheroid were oblate, then $f = 10$, $r = 15$, $x = 7{\cdot}62924$, and the content $= 3711{\cdot}024$ inches $= 13{\cdot}1597$ gallons.

Corollary.

From this ſolution it appears, that the value of x, or the height of the fruſtum, will be always the ſame, whatever the revolving axe AC may be; the ſaid height being to the ſemi-fixed-axe, or DF to DB, as ·762924 to 1.——And the content $1{\cdot}649344frr$ of the fruſtum $AEGC$ is to the ſemi-ſpheroid ABC or $2frr \times \frac{3{\cdot}1416}{3}$, as 2·474016 to 3·14159 &c. or as ·787504 to 1.——Alſo, the fruſtum in the oblate is to the fruſtum in the oblong ſemi-ſpheroid, as the longer axe to the ſhorter, which is the ſame proportions as the ſpheroids themſelves are in by Cor. 8 page 277 of Menſuration.

Mr. *Ri. Tapper*, by the doctrine of fluxions, gives this equation, $x^5 + \frac{5}{3}x^4 + \frac{4}{3}x^3 - \frac{2}{3}x = \frac{1}{3}$. Here the flowing quantity $x = \cdot 64638$. Hence this general theorem,

As 1 : the conjugate diameter of a ſpheroid :: ·64638 : the leſſer diameter of the largeſt conic fruſtum that can be inſcribed. Whence

The leſſer diameter — — 12·9277 } inches.
Height of the conic fruſtum 11·4455 }
The ſolid content — — 8·7734 ale gallons.

But Mr. *Andrew*, the propoſer, gives this general theorem, $x^6 - 425x^4 + 67500x^2 = 3796875$: and the leſſer diameter = 12·9297, and the content = 15·4587 ale gallons.

* II. *The 93d Queſtion anſwer'd by* Sylvia.

If the bearing of the ſhadow be N. N. W. the ſun muſt be upon the S. S. E. point, his azimuth then being 22° 30′ from the ſouth, and his declination being the 9th June 23° 30′. In the latitude of 54° his altitude is 58° 2′.

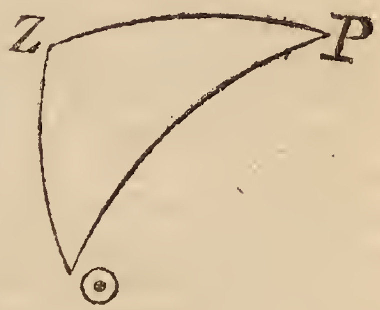
As the tangent of 45° 0′	— — —	10·0000000
To the tangent of 58 2	— — —	10·2047732
So is the logar. 253 foot	— —	2·4031204
To the logar. 403·4	— — —	2·6078937

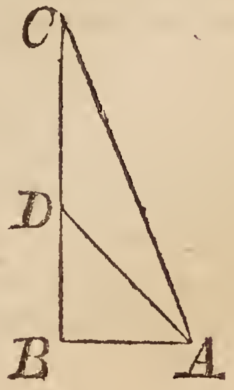
The height of the tower and fane together, but the fane's above the tower juſt 152·4 foot.

III. *The*

* II. QUESTION 93.

In the ſpherical triangle $ZP\odot$, given PZ the co-latitude = 36°, $P\odot$ the co-declination = 66° 30′, and the angle Z = the azimuth fr m the north = 157° 30′; to find the ſide $Z\odot$ = 31° 58′ = the co-altitude. Hence the altitude itſelf is 58° 2′ = $\angle BAC$ in the ſecond figure, in which the ſhadow AB = the tower BD = 253; then, by plane trigonometry, as radius : tang. $\angle BAC$ :: AB : BC = the height of the tower and vane together; from which taking away the height of the tower BD, there remains DC = the height of the vane, as in the original ſolution.





* III. *The 94th Queſtion anſwer'd by Mr.* Ri. Tapper.

Let $a =$ the greater ſegment taken from the perpendicular, $e =$ leſſer ſegment, and $s =$ their ſum $= 70$, p their product $1181\frac{3071}{9600}$ yards. There comes out this equation,

$$\left.\begin{array}{l} a = \frac{1}{2}s + \sqrt{\frac{1}{4}ss - p} = 41{\cdot}60909253049663547 \\ e = \frac{1}{2}s - \sqrt{\frac{1}{4}ss - p} = 28{\cdot}39090746950333453 \end{array}\right\} \text{yards.}$$

Put x for the unknown tangent, $h =$ the greater ſegment, $d =$ the leſſer, from whence this equation is brought out

$$x = \frac{dd + aa - hh - ee}{18} = 16{\cdot}404053014973987049944 5.$$

Hence the length of the walls are,

Longeſt 70,
Next - $55{\cdot}9045301497398704994 45$,
Shorteſt $46{\cdot}9045$ &c.

For the perpendicular's length, let $a =$ the ſhorteſt ſide; then, by Eucl. I. 47, $\sqrt{gg - ee} = 37{\cdot}40536$ yards.

Hence the area $= 1309{\cdot}1876$ ſquare yards $= 1$ ro. 3 per. &c.

To find the angle ſubtended by the perpendicular, and made by the ſhorteſt ſide and ſhorteſt ſegment.

As the leſs ſegment : radius :: perpendicular : tang. $52°\ 48'$.

As radius : tang. of $\frac{1}{2}$ laſt angle :: leſſer ſegment $30{\cdot}5$: $15{\cdot}14$, half of the diameter; ſo the diameter is $30{\cdot}28$.

IV. *The*

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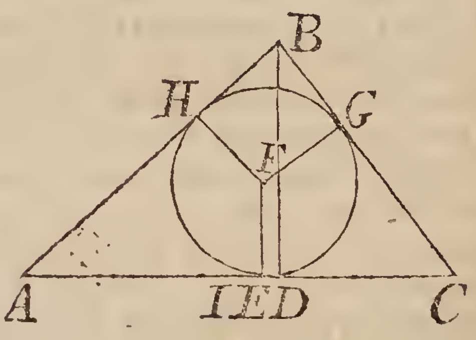
* III. QUESTION 94.

In this queſtion we have given, in the triangle ABC, the baſe $AC = 70$, the rectangle of the ſegments of the baſe, made by a perpendicular, $AD \times DC = 1181\frac{3071}{9600}$, and the ſegments of the baſe made at the point of contact of the inſcribed circle, viz. $AE = 39\frac{1}{2}$, and $CE = 30\frac{1}{2}$; to determine the triangle.



Algebraical Solution.

Put $s = 35 = AI = IC$, $p = 1181\frac{3071}{9600} = AD \times DC$, and $z = ID =$ half the difference between AD and DC. Then $AD = s + z$, and $DC = s - z$: hence their product $ss - zz = p$, and therefore $z = \sqrt{ss - p}$. Then $AD = AH = s + \sqrt{ss - p}$, and $DC = CG = s - \sqrt{ss - p}$.——Again, ſince

IV. *The 95th Question answer'd by Mrs.* Eliz. Dod.

If gaugers wou'd their business mind,
 And follow their excise;
They their account therein would find,
 Without this stir and noise;
Let 'em no more their boasted art
 Extol, since 'tis our aid
That does the tub's content impart,
 Tho' they for that are paid.

The

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since BH is $= BG$, we shall have the difference of the sides $AB - BC = AH - CG = AE - EC = 9$; then, by a known rule, $AE - EC : AD - DC :: AC : AB + BC$; the sum of the sides being then known, from it and their difference the sides themselves are easily found. Also $BD = \sqrt{BA^2 - AD^2}$, and $\frac{1}{2} BD \times AC =$ the area.——Lastly, the double area of the triangle being divided by its perimeter, the quotient will be the radius FE of the inscribed circle.

Geometrical Construction.

Let I be the middle of the given base AC, and E the point of contact with the circle. By Eucl. II. 14, make a square equal to the given rectangle of the segments of the base, which call S^2; then take ID equal one leg of a right-angled triangle of which S is the other leg and AI the hypothenuse; so shall AD, DC be the segments of the base made by the perpendicular.——For, by Eucl. II. 5, $AI^2 = AD \times DC + ID^2 = S^2 + ID^2$ by the construction; therefore AI, S, and ID form a right-angled triangle by Eucl. I. 48.

Again, take BG or BH a fourth proportional to $2IE$, ED, and AC; which being added to $AH = AE$, and to $CG = CE$, the two sums will be the two sides AB, BC, of the triangle.——For, by Eucl. III. 37, $AE = AH$, $CE = CG$, and $BH = BG$; and it remains only to prove that BG or BH is the 4th proportional mentioned above. Now, by Simpson's Geom. Cor. 2. 9. II, as $AB - BC : 2ID :: AC : AB + BC$; but $AB - BC$ ($= AH - CG = AE - EC$) $= 2IE$, and $AB + BC =$ ($AH + HB + BG + GC =$) $AC + 2BG$; therefore the proportion becomes $2IE : 2ID :: AC : AC + 2BG$; hence, by division, $2IE : 2ED :: AC : 2BG$, or $2IE : ED :: AC : BG$. *Q. E. D.*

The calculation from hence is very easy and evident.

The greatest diameter 48. Lesser 32. Depth 30 inches. Content 17·764834 malt bushels.*

† V. *The 96th Question answer'd.*

The three sides of the triangle are 42, 34, and 20 chains. The internal fences 24·586, 18·773, and 12·238. The content 33·6 acres.

Divide each side of the triangle into two equal parts, from whence draw lines to the angles opposite; the point in which these intersect is the center of gravity of the triangle; and and where it would be, if hung up, equally poised.

VI. *The*

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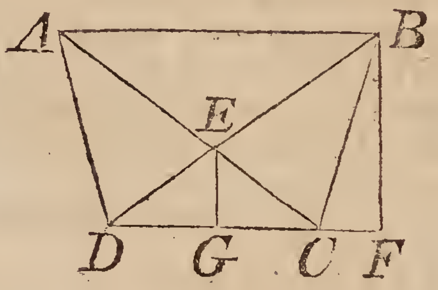
* IV. QUESTION 95.

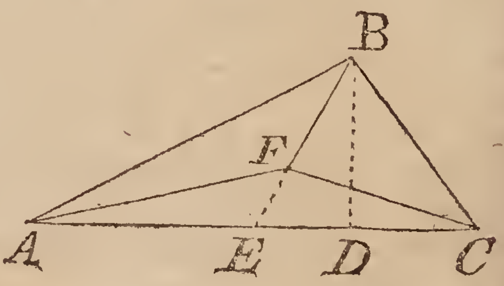
$ABCD$ being the tub, we have given $DC = 32$, $AE = EB = 30$, and $DE = EC = 20$.



Upon the middle of the base of the isosceles triangle DEC let fall the perpendicular from the angle E; and from the top of the tub let fall the perpendicular BF. Then, in the right-angled triangle DEG, $EG = \sqrt{DE^2 - DG^2} = \sqrt{20^2 - 16^2} = 12$; and in the similar triangles DEG, DBF, as $DE = 20 : EG = 12 :: DB = 50 : BF = 30$. Also, by similar triangles, $ED : DC :: EA : AB = 48$. Hence the content $= {\cdot}7854 \times BF \times \frac{AB^2 + AB \times DC + DC^2}{3} = 30 \times \frac{48^2 + 48 \times 32 + 32^2}{3} \times {\cdot}7854 = 12160 \times 3{\cdot}14159$ &c. $= 38201{\cdot}77$ cubic inches $= 17{\cdot}7648$ malt bushels.

† V. QUESTION 96.

Let AC be the base or longest side of the proposed triangle ABC, and BD the perpendicular.——Put $z = BC$ the shortest side, and $y =$ the other side AB. Then, by the question, $z - 2 = AD - DC$, and the greatest side AC (or $AD + DC$) $= 3 \cdot \overline{y - z}$, also the sum of all the three sides is $4y - 2z = 96$, or $2y - z = 48$. But, by the nature of the triangle, $AC : AB + BC$



$:: AB$

* VI. *The 97th Question anſwer'd by Mr.* C. Maſon.

It is evident this queſtion is compoſed from that in page 225 of Ward's Mathematician's Guide.

Suppoſe $\frac{aa}{2}$ = to his age.

$aa + a + 5 = 47$. Involved is
$a^4 + 2a^3 + 12aa + 11a + 30 = 2256 = b$. Then by completing the ſquare will be produced this canon,

$\sqrt{\sqrt{b + 0{\cdot}25} - 5{\cdot}25} - 0{\cdot}5 = a$, and $\frac{aa}{2} = 18$ years old.

To

$::AB - BC : AD - DC$, or $3 . \overline{y - z} \times \overline{z - 2} = \overline{y + z} \times \overline{y - z}$; hence $3 . z - 2 = y + z$, or $2z - y = 6$. From this equation, and the one above, viz. $2y - z = 48$, we eaſily find $z = 20$, and $y = 34$. Conſequently the third ſide $3 . \overline{y - z}$ is 42.

Now the point F upon which the triangle will be in equilibrium is the center of gravity; and lines drawn through the center of gravity, from the angular points, biſect the oppoſite ſides; that is, BF produced biſects AC in E; alſo the diſtance between the angular point and the center of gravity is two-thirds of the whole line, that is $BF = \frac{2}{3} BE$. But, by theor. II book 3 Simp. Geom. it is $2BE^2 + \frac{1}{2} AC^2 = AB^2 + BC^2$; hence $BF\ (= \frac{2}{3} BE) = \frac{2}{3}\sqrt{\frac{AB^2 + BC^2 - \frac{1}{2}AC^2}{2}} = 12{\cdot}238373$. In the ſame manner AF is $= \frac{2}{3}\sqrt{\frac{AB^2 + AC^2 - \frac{1}{2}BC^2}{2}} = 24{\cdot}5854519$, and $CF = \frac{2}{3}\sqrt{\frac{AC^2 + CB^2 - \frac{1}{2}AB^2}{2}} = 18{\cdot}77350379$.

* VI. QUESTION 97.

The method of completing the ſquare in the above original ſolution is thus.——Since $a^4 + 2a^3 + 12a^2 + 11a + 30$ is $= \overline{aa + a + 5}|^2 + aa + a + 5 = b$; by completing the ſquare, we have $aa + a + 5 = \sqrt{b + 0{\cdot}25} - 0{\cdot}5$; and, by completing the ſquare again, it is $a = \sqrt{\sqrt{b + 0{\cdot}25} - 5{\cdot}25} - 0{\cdot}5 = 6$. And then $\frac{1}{2} aa = 18$.

To this Question Cælia Beighton *thus answers.*

I've view'd your query, Mr. Tapper, well,
And found a rule by which your age to tell.
" Extract th' square root o'th' number giv'n,
" Quote or remainders forty-seven ;
" From whence take five, and there remains
" Just forty-two, which with small pains
" You may extract, the root is six,
" And six remains ; therefore I fix
" The square of six your double age :
" From hence you have a theorem true,
" Which now I have explain'd to you.

* VII. *The 98th Question answer'd by Mr.* Lewis Evan.

Put a, e, u = their several losses, b = 2000, and c = 9000. Then

$$\left.\begin{array}{l} a = b + c \\ e = c \\ u = b \end{array}\right\} + \sqrt{2bc} = \left\{\begin{array}{ll} 17000 & A \\ 15000 & B \\ 8000 & C \end{array}\right\} \text{ lost.}$$

The

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* VII. QUESTION 98.

The theorems, in the original solution above, for determining the values of the three quantities required, are found thus.

Denoting the two differences between the greatest and each of the other two by b and c, as above, and the least quantity itself by x; then $x + c$ = the greatest, and $x + c - b$ = the middle one : hence, by the question, $\overline{x+c}|^2 = x^2 + \overline{x+c-b}|^2$; from which equation we have $x = b + \sqrt{2bc}$.

Then $x + c - b = c + \sqrt{2bc}$,

and $x + c = b + c + \sqrt{2bc}$,

which are the three quantities required.

* The Prize Queſtion anſwer'd.

Auguſt 18, 1718, Adraſtea let fall 3 ſeveral ſtones into Eldon-hole, which fell with little or no obſtruction, and accelerated in 9, 11, and 10 ſeconds from their delivery to to the ſound's reaching the ear: Sir Iſaac Newton ſays heavy bodies fall 16·5 foot the firſt ſecond, then 3, 5, 7, 9, &c. times ſo much in the ſucceeding ſeconds, and that ſound moves 968 feet in a ſecond. Then $10'' \times 10'' = 100 \times 16{\cdot}5$, 1650 feet ÷ by 968 $= 1''\ 42'''$ for the approach of ſound. So the ſtone was falling but $8\frac{1}{4}''$; $8{\cdot}25 \times 8{\cdot}25 = 68{\cdot}0625 \times 16{\cdot}5 = 1123$ feet $= 374{\cdot}34$ yards.

But

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* PRIZE QUESTION.

This problem is of the nature of Sir I. Newton's 50th prob. in his Univerſal Arith. who has there given the true method of ſolution much in this manner.

Put x for the depth of the hole, $a = 16\frac{1}{12}$ feet the diſtance fallen by a body in the firſt ſecond of time, and $b = 1142$ feet = the velocity of ſound per ſecond; alſo $t =$ the given time of hearing the ſound, found by the experiment.——Then, by the nature of falling bodies, $\sqrt{a} : \sqrt{x} :: 1'' : \sqrt{\frac{x}{a}} =$ the time of the ſtone's falling to the bottom; and, by the uniform motion of ſound, $b : x :: 1'' : \frac{x}{b} =$ the time in which the ſound will aſcend through the ſpace x. Then the ſum of theſe two times will be equal to the whole time, that is $\frac{x}{b} + \sqrt{\frac{x}{a}} = t$.—— Now the times in which pendulums make an equal number of vibrations, being as the roots of the lengths, and a pendulum 39·2 inches long vibrating 8 times in 8 ſeconds, we ſhall have $\sqrt{39{\cdot}2} : \sqrt{61} :: 8'' : 8\sqrt{\frac{61}{39{\cdot}2}} = 10''$ (extremely near) $= t$ the time in which a pendulum of 61 inches ſwings 8 times: then the above theorem $\frac{x}{b} + \sqrt{\frac{x}{a}} = t$ becomes $\frac{x}{1142} + \sqrt{\frac{x}{16\frac{1}{12}}} = 10$. Hence $x = 1270{\cdot}4$ feet $= 423\frac{1}{2}$ yards = the depth required.

The theorem at the top of the next page I cannot reduce to a proper form, nor diſcover what the author means by it; it is evidently nonſenſe as it ſtands, but I have printed it exactly as I found it.

But by Dr. Hally's numbers, let $a = 16$ foot 1 inch, $b =$ 1142 feet the motion of ſound, $t =$ the time, x the depth; there will ariſe this theorem,

$$x = \frac{abt \times \frac{1}{2}a}{b^2} \quad \frac{a}{2bb} \sqrt{4bt \times 1} = 1265{\cdot}82 \text{ feet.}$$

N. B. The method taught in Lexicon Technicum, and ſeveral authors, to find a depth by the falling of heavy bodies, is falſe. The time the ſound is reaching the ear, muſt be deducted out of the latter part of the ſtone's falling. In that author's example, under the word pendulum, according to the time of the body's falling, the well is 256 foot deep; then he allows for the ſound's aſcending $\frac{1}{3}$ of 16 foot to be ſubtracted, makes it juſt 250 feet: whereas in the laſt ſecond, the ſtone fell 112 feet, therefore $\frac{1}{3}$ of that (at leaſt) muſt be deducted, it will be but 225 feet.

The prize of 10 *diaries fell to Mr.* Chriſt. Maſon *of London.*

Of the Eclipſes in 1723.

1. Sun eclipſed, Thurſday the 23d of May, a quarter paſt 3 in the morning, inviſible.

2. Moon eclipſed, June the 7th, at 4 in the afternoon, inviſible.

3. Sun eclipſed, November the 16th, 3 quarters paſt 9 at night, and inviſible.*

New

* This year, in the months of October, November, and December, a ſmall new comet was obſerved by Mr. *Bradley*, Dr. *Halley*, and ſeveral others; from whoſe obſervations and calculations it appears that,

The inclination of its orbit and ecliptic was —		$49°$	$59'$	$0''$
The place of the aſcending node — —	♈	14	16	0
The place of the perihelion — — —	♉	12	52	20
The diſtance of the perihelion from the node —		28	36	20
The log. of the perihelion diſtance — — —		9·999414		
The log. of the diurnal motion — — —		9·961007		

The equal time of its being in its perihelion Sept. 16 d. 16 h. 10 m. In its orbit thus ſituated, the motion of the comet was retrograde or contrary to the order of the ſigns.

New Paradoxes.

Par. 1. There is a certain noted place in the vaſt Atlantic ocean, where a briſk Levant is abſolutely the beſt wind for a ſhip that is to ſhape a due eaſt courſe, and yet ſhe ſhall ſtill go before it.

Par. 2. It may be clearly demonſtrated by the terreſtrial globe, that it is not above twenty-four hours ſailing from the river of Thames in England, to the city of Meſſina in Sicily, at a certain time of the year; provided there be a briſk north wind, a light frigate, and an azimuth compaſs.

Par. 3, *by Mr.* Richard Tapper.

A certain mount in Devonſhire doth ſtand,
Whoſe lofty head o'erlooks the neighb'ring land;
And ſuch is the known property o'th' hill,
That if a veſſel you with liquor fill
At the hill's top or vertex of this place,
It holds leſs than if filled at the baſe.
Now what's the cauſe of this deficiency,
Pray let me know in the next diary.

Par. 4, *by Mr.* Chriſt. Maſon.

When tyrant Noll, at fatal Worc'ſter fight,
His crew harangu'd, againſt both law and right;
His quaint numerique no two did hear,
Tho' ſev'ral thouſand miſcreants were there:
For ev'ry man, and ev'ry ſev'ral ear,
Did not the ſame, but different voices hear.

New Queſtions.

I. *Queſtion* 99, *by Mr.* C. Maſon.

Two ancient towns, for two true lovers fam'd,
Abydos one, the other Seſtus nam'd;
Thro' Abydos Leander's praiſes rung,
In Seſtus they of Hero's beauty ſung:
The Helleſpont thoſe noted towns did part,
But was no bounds to love's unerring dart:
When ſhe the greatneſs of her power diſplay'd,
And ſuch a wound at ſuch a diſtance made.

But

But cruel fate their free accefs deny'd,
And kept 'em pris'ners on each diftant fide.
She was confin'd like Danae in a tow'r,
Yet conquer'd was without a golden fhow'r:
He fo confin'd upon his native fhore,
No boats nor barges e'er durft waft him o'er.
Each had a view of the adjacent lands,
Plac'd oppofite upon the lonefome ftrands.
Tho' boift'rous furges did with envy roar,
And dafh with fury on the patient fhore;
His darling love wou'd no fuch bars allow,
But naked ftripp'd did on the billows plow:
With fpeed he cut his proud triumphant way,
As flutt'ring waves did round his body play.
In equal times he equal fpaces ply'd,
Swift as the waves did o'er the channel glide;
Each tow'ring wave the former did fucceed,
Juft forty foot rolling with equal fpeed.
If equidiftant from each place you were,
And the obfervation angle fhou'd appear
Juft forty-three degrees; move t'wards 'em ftreight,
Five furlongs juft, the angle's forty-eight.
The breadth o'th' Bofphorus I pray explore,
Likewife the time he fwam 'twixt fhore and fhore.

II. *Queftion* 100, *by Mr.* John Richards.

From Edyftone viewing the neighb'ring fhore,
And willing to know how far it is o'er,
To three ports within fight; their diftances are known,
From each other, as here under I have fhown.
I thought the beft I cou'd do was to try,
Which way from the rock thofe three places lie;
This I have done, and it is noted here.
Pray what will the three diftances appear?

The diftance from	Plymouth to Lizard 60 Lizard to Start Point 70 Start Point to Plymouth 20	miles.

Plymouth Lizard Start Point	bears from Edyftone rock	North. W. S. W. E. b. N.

III. *Queftion*

III. *Question* 101, *by Mr.* John Willingham.

One evening from a mountain high,
Soon as the ſun was down,
Looking towards the eaſtern ſky,
I ſaw the riſing moon;
Her diſtance from the zenith then,
Streight way I did explore,
And found degrees fourſcore and ten,
And fifty minutes more.
A tube inclining one degree,
And minutes fifty-eight,
Thro' which a ſhip appear'd at ſea,
Full crowding on my ſight:
The diſtance of that ſhip, o'th' main,
In leagues I do require,
Likewiſe what height above the plain
That mountain does aſpire.

IV. *Question* 102, *by Mr.* John Simmons.

In maſon's yard there happened to roll
A pyramid's fruſtum into a plaſhy hole,
Whoſe baſes are (in form) octagonal.
The leſs baſe ſides juſt touch'd the water's brink,
The greater baſe did wholly in it ſink;
So that the level ſurface of the water
Did nicely cut (or very near the matter)
The fruſtum with a line diagonal.
Being thus immers'd, I cou'd not take all
Uſual dimenſions; which made me fret,
'Cauſe I each part's ſolidity muſt get,
Both of the dry, in inches, and the wet.
To help me out a friend gave me a line,
That was divided in extream and mean:
The greater ſegment was the length o'th' ſide,
Leſs baſe's breadth the other;——he alſo ſaid,
That baſe and ſide an obtuſe angle making,
Of juſt fiveſcore degrees (when 'twas taken)
And this the fruſtum's whole ſolidity. 158821·64
I've loſt the line, and the taſk's too hard for me;
Ladies—Pray ſolve the ſame in your next diary.

V. *Question* 103, *by Mr.* Will Doidge.

Of you, fair ladies, I a favour ſue,
'Tis your bright genius muſt reſolve it too.
I in a garden have a piece of ground
In oval form, the tranſverſe I have found
Juſt fifteen feet, the conjugate was ten;
An ordinate which cuts the tranſverſe length,
From off the center juſt three feet two-tenth;
Not rightly apply'd, but inclined laid,
And ſev'nty-two degrees an angle made.
What length each part is from the tranſverſe axe,
Of you, bright wits, I with ſubmiſſion aſk.

VI. *Question* 104, *by Mr.* Tho. Williams.

Wand'ring Æneas, long with tempeſts toſt,
Was thrown upon the famous Libyan coaſt,
Where mighty Carthage ſtood, and Dido queen,
Late come from Tyrus with her ſlender train.
This ſplendid town (a village late) they view,
Whilſt Tyrians do their daily taſk purſue,
And dig foundations for their building maſters,
Hewing out and making fine pilaſters.
One ſtone among the reſt was fixed there,
Of poliſh'd marble wrought, its baſe four-ſquare;
Its curious ſhape was pyramidical,
Its lofty height twice the diagonal:
And whilſt Æneas view'd this finiſh'd ſtone,
The maſon ſaid, Thou pious mighty ſon
Of old Anchyſes, by the foot 'twas made,
But being unmeaſur'd, I am ſtill unpaid;
And muſt be ſo, unleſs ſome artiſt's ſkill,
More than my own, that taſk for me fulfil.
Its weight is juſt forty-eight tun complete;
But how from thence to find its ſolid feet,
I know not; but deſire that, aiding, you
Wou'd that and its dimenſions ſhew.

The Prize Question.

When brilliant wits the ſplendid forms wou'd ſhew
Of niceſt architecture to our view;
Nothing near home is worthy of their note,
But all's fetch'd from thoſe kingdoms more remote.

Rome, Egypt, Italy, or ancient Greece,
Is art's as well as nature's maſter-piece;
Magnificent their turrets, pyramids
Rearing above the clouds their lofty heads:
Their putrid waters muſt be cryſtalline,
Their common pebbles orient pearls out-ſhine;
Their verdant meads from pinching froſts be free'd,
And never-fading blooms the trees o'erſpread.
  Thus the fantaſtic humours of the age
Delight themſelves, and all their thoughts engage
To things of foreign growth, or antic mien,
Neglecting what's more eaſy to be ſeen.
If from the heathen poets tales they tell,
It proves a modern proper vehicle,
To paſs the airy gilded phantom down,
Pall'd with more worthy objects of their own.
Strangely deprav'd ſuch fleeting fancies are,
And like weak eyes diſtinguiſh nothing near
Without their optic glaſſes; but from far
Miſtake a lamp for Titan's riſing car.
  Yet ſtately ſtructures thus deſcrib'd we prize,
And much relent we ſhou'd thoſe rules deſpiſe
The Romans brought; and, in the Gothic way,
Without a rule or order, art diſplay.
  But notwithſtanding that, we may behold
Amongſt us buildings beautiful and old;
Weſtminſter Abbey, and St. Peter's, York,
King's College, Cambridge, admirable work;
And, tho' leſs fam'd, as juſtly may admire;
Amongſt the reſt, that noble lofty ſpire
To the Botoners honour built in Coventry,
Second to none in ſprightly ſymmetry,
Only o'er-top'd in height by Saliſbury.
In ev'ry part it entertains the eye
With ſtatuary work, and fine embroidery:
Yet full of ſtrength and grandeur, that it ſeems
A geometric mean, 'twixt two extreams.
  And altho' mathematic inſtruments
Furniſh with methods for its full extents;
I'll here propoſe, from algebraic art,
And from a theorem Euclid does impart,
To find its height, without the help of thoſe,
And freely tell the rule that I have choſe.
"An ancient houſe there ſtood in a low place,
"Whoſe top's exactly level with the baſe,
"Or ſteeple's bottom: then I take my ſtand
"A diſtance off, but ſtill on lower land;

To

" To th' houſe and ſpire I my eye confine,
" And find it runs directly in a line;
" And diſtant from the foot along the ground,
" Two hundred and eighty-two feet two-tenths is found; 282'2
" The horizontal line, from the houſe-top muſt be
" Juſt the ſame numbers you i'th' margin ſee.* * $228\frac{3}{4}$
" That from my eye to th' top, I do declare,
" Added to th' higheſt perpendicular,
" In feet theſe numbers will exactly give,
" Four cents, above ſeven hundred ſeventy-five. 775'04

1724.

Paradoxes anſwered.

Paradox 1 *anſwer'd.*

IF the place be eaſtward of the Levant, a ſhip may be carried by an eaſt wind round the globe to it; provided ſome eaſt point be fix'd. *Ja. Wylde.* Or, where there is a violent tide. *Oedipus Sebaſtienſis.* 'Tis meant the gulph of Florida. *J. Richards, T. Gill.* But the quibble may lie in the word *ſhape*, for an eaſt wind may be beſt for carrying her out of an harbour to ſail to a place on the eaſtern part of that iſland or continent.

Par. 2. Is meant the artificial globe and the hand index.

Par. 3. Water has its ſurface always of a ſpherical figure; and that fartheſt from the earth's center is leaſt ſwelling, and conſequently holds leaſt above the brim of the veſſel.

Par. 4. Sound being efflated in concentric circles, as a ſtone falling into water moves it all round, ſo that part of a circle which touch'd one man's ear, could not touch another's who cou'd not be in the ſame individual ſpot of ground.

Queſtions

Questions answer'd.

* I. *The 99th Question answer'd by Mr.* Rich. Tapper.

As the rectangle of the radius and the sine of 2° 30′ : the rectangle of the sines of 24° and 21° 30′ :: 3300 = 5 furlongs : half the breadth of the Bosphorus 11277·764613 feet. The whole breadth is 7515·1764 yards = 34 furlongs 35 yards = 4 miles 2 furl. 35 yards. Then (according to Sir Isaac Newton) a wave runs thro' its breadth, whilst a pendulum, whose length is equal to that breadth, oscillates or vibrates once. A pendulum of 40 feet in length vibrates 17·14642817 times a minute. Consequently he swam 685·85 feet per minute. From hence the time is 32′ 53″ 11‴ 52⁗.

The proposer and some others give the answer 7518·7 yards, and the time 33 min. or 32·9039.

II. *Question*

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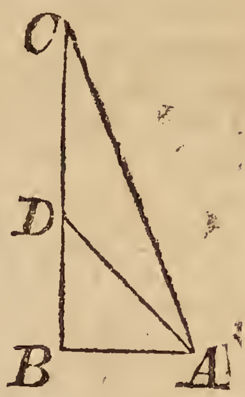
* I. QUESTION 99.

If C and D represent the two places of observation, and AB half the breadth of the Bosphorus: then we have given all the angles and the line CD, to find AB; viz. $\angle C = 21° 30'$ = half the first observed angle, $\angle BDA = 24°$ = half the latter, $\angle DAC = (\angle D - \angle C =)\ 2° 30'$, and CD = 5 furlongs = 3300 feet.——Hence, by common trigonometry,



s. CAD : s. C :: CD : DA, and

radius : s. D :: DA : AB; hence by compounding these two proportions, &c.

radius × s. CAD : s. D × s. C :: CD : AB, that is

radius × s. 2° 30′ : s. 24° × s. 21° 30′ :: 3300 feet : half the breadth of the Bosphorus, as in the original solution.

Again, by the nature of pendulums, $\sqrt{\frac{39\cdot2}{12}} : \sqrt{40} :: 1'' : \sqrt{\frac{40\times12}{39\cdot2}} = \frac{10\sqrt{6}}{7} = 3\frac{1}{2}$ seconds, very nearly, = the time in which a pendulum of 40 feet makes one vibration, or = the time in which the wave or the swimmer moves 40 feet. And, consequently, as 40 feet : $3\frac{1}{2}''$ :: the whole distance : time of swimming,

II. *Question* 100 *answer'd by Mr.* John Topham.

This question is to be found in Philosophical Transactions, proposed by Mr. Townley, with Mr. Collins's constructions to all its cases. From Edystone to Lizard 53·112 miles, to Start Point 17·134, to Plymouth 14·187.

The question being somewhat curious, I shall here give the method of solving it. Because any two of the angles answering the rumbs given in the question, exceed 180 degrees, the point where Edystone stands must fall within the triangle. Then if you suppose a circle to pass thro' Lizard, Edystone, and Start, and bisect the line between Lizard and Start,

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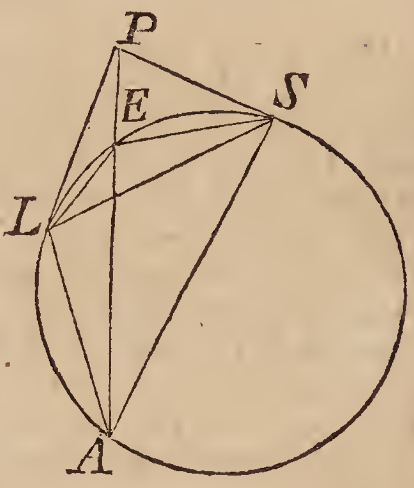
* II. QUESTION 100.

Another method of construction and calculation may be thus.

Construction.

With the three given distances, 60, 70, and 20, make the triangle LPS, wherein P will be Plymouth, L the Lizard, and S the Start. Then if E be supposed to represent the Edystone, the direction EP being North, ES being E. by N. and EL being W. S. W. there will be known all the angles about the point E. Hence, supposing PE produced to A, if on LS there be described the segment of a circle LES to contain the given angle LES = 15 points or 168° 45′, and then there be made either the angle SLA = 9 points = $\angle AES$, or the angle LSA = 6 points = $\angle AEL$, LA or SA cutting the circle in A; it is evident that E will be the point of intersection of AP with the circle.



Calculation.

1. In the triangle LPS, are given all the sides, and of consequence the angle PSL.——2. In the triangle ALS, are given LS, the $\angle ASL$ (by constr.) and the $\angle A$ = the supplement of $\angle LES$; to find SA.——3. In the triangle PSA, are given PS, SA, and $\angle S$; to find $\angle PAS = \angle SLE$, and $\angle APS$.——4. In the triangle LES, are given the angles and the side LS; to find LE and ES.——5. And, lastly, in the triangle PSE, are given the angles and the side SP; to find PE.

Start, producing ſuch line through the center of that circle to the periphery, lines drawn from the point in the periphery to Lizard and Start, with the two lines from Edyſtone to Lizard, and from Edyſtone to Start, will be a trapezia inſcrib'd in a circle, which according to 22 Euclid 3, the two oppoſite angles taken together are equal to two right angles; conſequently the angle at the periphery is 11° 15′, the complement to that at Edyſtone 168° 45′ given. In like manner, let a circle paſs through Plymouth, Edyſtone, and Lizard, the angle at the periphery will be 67° 30′, the complement to the other rumb given, 112° 30′. Again, if from the center of the firſt circle you draw lines to Lizard and Start, the angle contain'd between them will be double to that at the circumference, by 20 prop. Euclid 3, viz. 22° 30′; and in the other circle 135°. Then,

s. 11° 15′ : log. of $\frac{1}{2}$ 70 miles given : : radius : ſemi-diam. circle 179·4. Alſo,

s. 67° 30′ : log. of $\frac{1}{2}$ 60 miles given : : radius : ſemi-diam. circle 32·47.

Now there is given the two ſemi-diameters of the circles; and the angle between them = 116·38, to find the angle ſubtended by the leſſer ſemi-diameter.

As ſum ſides : difference : : tang. $\frac{1}{2}$ oppoſite angles : tang. of $\frac{1}{2}$ the difference of the angles; which angle is 8° 31′. Then radius : log. 179·3 : : s. 8° 31′ : log. of 26·52; which doubled is the diſtance between Edyſtone and Lizard 53·04 miles. For the other two, there are 2 ſides, and an angle oppoſite to one of them, given, to find the other ſide. Hence from Edyſtone to Plymouth is 14·333 miles, and from Edyſtone to Start Point 17·36.

III. *Queſtion* 101 *anſwer'd by Mr.* Tapper.

As radius : the ſecant of 50′ : : ſemi-diam. earth : the ſemi-diam. and height of the mountain in one ſum. Sem. earth : s. 88° 2′ : : laſt ſum : s. angle oppoſite 91° 47′. Conſequently the angle at the center is known.

If the diameter of the earth be, as Norwood makes it, 41899310 Engliſh feet, the mountain's height will be = 2216·473 feet, the ſhip's diſtance 14·6288 miles, and from the baſe of the mountain on the arch of a great circle 12·726.

N. B. The propoſer gives this anſwer, viz. The mountain's height 746 yards $\frac{3}{4}$, at 70 miles to a degree; the ſhip's diſtance 3 leagues 2 miles. But ſome others, accord-

ing to the difference of miles to a degree, 881 yards and 5 leagues, &c.*

† IV. *Queſtion* 102 *anſwer'd by the ſame.*

Let $a = \cdot 82847$, the area of an octagon whoſe diameter is 1, $C =$ content of the fruſtum, $s =$ ſine 10°, $c =$ its coſine, $r =$ radius, $x =$ diameter of leſſer baſe, $y =$ the ſlant ſide of the fruſtum more the leſſer baſe; then $axx =$ the area of leſſer baſe, and the ſlant height $= y - x$. Therefore $y : y - x :: y - x : x$ by the nature of the line.

And

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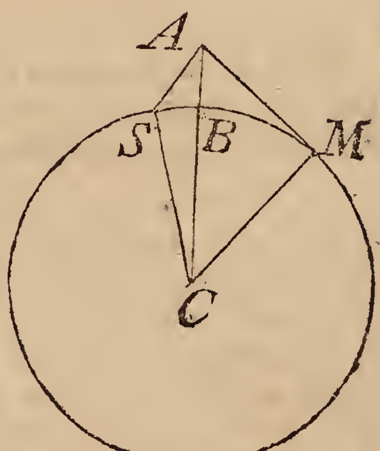
* III. QUESTION 101.

The above original ſolution will be evident from this figure; in which C repreſents the center of the earth, AB the hill, S the ſhip, and AM a tangent to the earth directed to the riſing moon. For, M being a right angle, and $\angle ACM = 50'$, whoſe tangent is MA and ſecant AC, it will be as radius : ſec. $\angle ACM :: CM : CA$. ——Again, the $\angle SAC$ being $= 88°\ 2'$, and the ſides CS, CA known; we thence find the third ſide $AS =$ the diſtance of the ſhip from the top of the mountain; as alſo the $\angle SCA$, and conſequently the arch SB the diſtance of the ſhip from the bottom of the mountain.



† IV. QUESTION 102.

The ſolution to this queſtion will perhaps appear a little clearer thus.——The ſlant ſide being the greater part, and the diameter of the circle inſcribed in the leſs end the leſs part of a line divided in extreme and mean proportion; the meaning of which is, that the greater part is a mean proportional between the leſs part and the whole, that is $xx = \overline{x + y} \times y = xy + yy$, putting $x =$ the greater part or the ſlant height, and $y =$ the leſs or the diameter of the circle in the leſs end. Now from this quadratic equation is found $y = \frac{\sqrt{5} - 1}{2} x = ax$, putting $a = \frac{\sqrt{5} - 1}{2}$.

Now, the ſlant ſide making an angle of 100° with the leſs end, or of 80° with the greater, put s and c for the ſine and coſine of 80°; then sx will be the altitude of the ſolid, and cx the half difference

And $yy - 2yx + xx = yx$. Hence $y = 1{\cdot}5 + \sqrt{\frac{5}{4}}x$.
And $y - x = {\cdot}5 + \sqrt{\frac{5}{4}}x$ = the slant side.

As radius : ${\cdot}5 + \sqrt{\frac{5}{4}}x :: s : \frac{{\cdot}5s + s\sqrt{\frac{5}{4}}x}{r}$ = the half difference of the breadths of the two bases. And consequently $1 + \frac{s + 2s\sqrt{\frac{5}{4}}x}{r}$ = the breadth of the greater base $= bx$. Then the area of the greatest base $= abbxx$, and the geometrical mean area $= abxx$. Then

As radius : ${\cdot}5 + \sqrt{\frac{5}{4}}x :: c : \frac{{\cdot}5c + c\sqrt{\frac{5}{4}}x}{r}$ = the altiude of the frustum $= dx$. And by multiplication we have $\frac{1}{3}adx^3 \times \overline{bb + b + 1} = G = \frac{1}{3}$ of the three areas multiplied by dx the height $= mxxx$. And hence $x = \sqrt[3]{\frac{G}{m}} =$ $41{\cdot}633534$ inches. Then making the square root of the area of the lesser base $= d$, the greater $= D$, the height $= H$.

			By *J. Painter*.
$\overline{DD + \frac{DDd}{D+d}} \times \frac{1}{3}H = 107707{\cdot}75$ the wet part.			$107784{\cdot}57$
$\overline{dd + \frac{ddD}{D+d}} \times \frac{1}{3}H = 51113{\cdot}89$ the dry part.			$51637{\cdot}07$
Breadth of lesser base	— —	$41{\cdot}6335$	$41{\cdot}6641$
Side of lesser base	— — —	$17{\cdot}2451$	$17{\cdot}2530$
Breadth	of greater base —	$65{\cdot}0286$	$65{\cdot}0720$
Side	of greater base —	$26{\cdot}9357$	$26{\cdot}9524$
Altitude	— — — —	$66{\cdot}3410$	$66{\cdot}3290$
Slant height	— — — —	$67{\cdot}3674$	$67{\cdot}4040$
Area of	lesser base — —	$1435{\cdot}9551$	$1437{\cdot}66$
Area of	greater base — —	$3503{\cdot}2256$	$3507{\cdot}19$

V. *Question*

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ference between the diameters of the two ends; and consequently $y + 2cx$ or $ax + 2cx$ = the diameter of the circle in the greater end $= bx$, putting $b = a + 2c$.——Then, putting n for the area of the octagon, the diameter of whose inscribed circle is 1, we shall have na^2x^2 and nb^2x^2 for the areas of the two ends, and $nabx^2$ their mean proportional; hence the content will be $sx \times \frac{na^2x^2 + nabx^2 + nb^2x^2}{3} = 158821{\cdot}64 = d$, from which is found $x = \sqrt[3]{\frac{3d}{ns \times \overline{aa + ab + bb}}}$. Consequently all the parts become known, and thence the content of each hoof as in the original solution.

* V. *Question* 103 *answer'd by Mr.* J. Painter.

The length of the greater part of the ordinate 5·18, and the lesser 4·23.

By Mr. *Tapper*, 5·13416 and 4·20625.

† VI. *Question* 104 *answer'd.*

A cubic inch of marble weighs 1·56185 ounces avoirdupois, so the content of the pyramid is 634·5729257 solid feet. The proportion of the side of a square to its diagonal, is as 1 to 1·4142. Multiply the solid content by 3, and divide the product by 2, gives 952·782, which multiplied by the square of 1·4142 = 1·99936, gives 1906, whose cube root is 12·319, the diagonal. Divide 952·78 by 12·31, gives 76·89, whose square root 8·768 is the side of the square sought.

The

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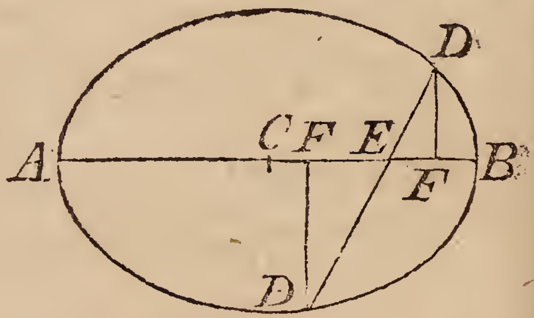
* V. QUESTION 103.

Let DD be the line cutting the transverse AB in an angle of 72 degrees at the point E; draw the perpendiculars DF.

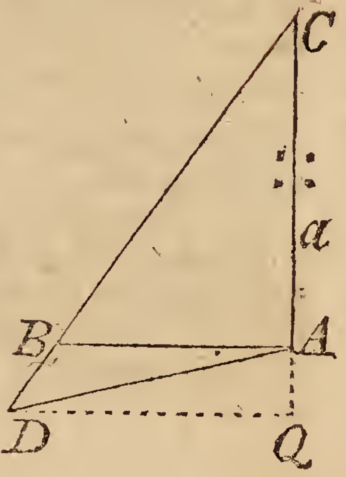


Put $m =$ semi-transverse, $n =$ semi-conjugate, $a = CE$, s and $c =$ sine and cosine $\angle E = 72°$, and $x = DE$.——Then $DF = sx$, $EF = cx$, and $CF = a \pm cx$; hence, by the nature of the ellipse, $m^2 : n^2 :: \overline{m + a \pm cx} \times \overline{m - a \mp cx} : s^2 x^2 = n^2 \times \frac{m^2 - \overline{a \pm cx}|^2}{mm}$; this equation reduced becomes $xx \pm \cdot 9282248 x = 21 \cdot 5945$; hence $x = 4 \cdot 206$ or $5 \cdot 1342 =$ the two parts required.

† VI. QUESTION 104.

The content being found as in the original solution above, put it $= c$, and $x =$ the side of the square base. Then $xx =$ the area of the base, $x\sqrt{2} =$ the diagonal, and $2x\sqrt{2} =$ the height. Hence the content $\frac{2x^3\sqrt{2}}{3} = c$; then $x = \sqrt[3]{\frac{3c}{2\sqrt{2}}} =$ the side of the base, and $(2x\sqrt{2} =) \sqrt[3]{24c} = 2\sqrt[3]{3c} =$ the height.

* *The Prize Question answer'd by* J. Painter.



Put $CA + CD = 775{\cdot}04 = s$,

$AD = 282{\cdot}2 = d$, $AB = 228{\cdot}75 = b$;

Substitute $2x = ss - dd$,

Which by the process in Ward's Math. Guide, p. 336, at the 21st step, you will have

$$\frac{ssaa - 23a^3 + a^4}{bb + aa} = \frac{xx - 2xsa + 2xaa + ssaa - 2sa^3 + a^4}{aa}.$$

Which.

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* PRIZE QUESTION.

The process for finding the equation in the above original solution, may be thus:

Put $s = AC + CD$, $b = AB$, $d = AD$, and $z = AC$ the height of the steeple; then $s - z = CD$. Draw DQ perpendicular to CA produced in Q.——Now, by right-angled triangles, $BC = \sqrt{bb + zz}$; and, by similar triangles, $CB : CD$ $:: \left\{\begin{matrix} CA : CQ = \dfrac{s - z}{\sqrt{bb + zz}}z \\ AB : QD = \dfrac{s - z}{\sqrt{bb + zz}}b \end{matrix}\right\}$; hence $QA = QC - CA$ $= \dfrac{s - z}{\sqrt{bb + zz}}z - z$; and then, by right-angled triangles again, $dd = AQ^2 + QD^2$, which equation reduced, and $2aa$ written for $ss - dd$, we have

$$\left.\begin{matrix}+2a^2\\+b^2\end{matrix}\right\}z^4 \left.\begin{matrix}-2a^2s\\-2b^2s\end{matrix}\right\}z^3 \left.\begin{matrix}+a^4\\+2a^2b^2\\+b^2s^2\end{matrix}\right\}z^2 - 2a^2b^2sz =$$

a^4b^2, which is the equation required.

Which being reduced by multiplication and tranſpoſition, will ſtand, $-bba^4 - 2xa^4 + 2sbba^3 + 2xsa^3 - 2bbxaa - bbssaa - xxaa + 2bbxsa = xxbb$. In numbers, $-573376{\cdot}72\,a^4 + 484945075{\cdot}246\,a^3 - 126569950746{\cdot}798\,aa + 21131282571666{\cdot}926\,a = 355157630053136{8}{\cdot}689$. If the terms be divided, it will ſtand, $-a^4 + 845{\cdot}77\,a^3 - 220744{\cdot}848\,aa + 36854112{\cdot}9\,a = 6192379528{\cdot}849$.

From hence will be found a the height of the ſteeple $=$ 310·8409 feet.

But if there had not happen'd a miſtake in the laſt line in printing the queſtion, which ſhould be 755·04, the anſwer had been 300 feet, the true height of Coventry ſpire, as I actually meaſur'd it both by lines and inſtruments, Sept. 26, 1721.

A Letter to the Author.

SIR,

I have oftentimes thought the compoſition of the enigmas and queſtions might be improved, and was therefore mightily pleaſed to ſee in your laſt year's diary ſuch uſeful and neceſſary hints for the compoſing a proper enigma. But I have often privately complain'd that arithmetical queſtions have been very dubious and unintelligible; and therefore could wiſh ſome neceſſary directions were laid down, to guide perſons of a good mathematical genius to a proper way of diverting their thoughts upon ſuch occaſions. And,

1. The moſt natural method in anſwering the queſtions, ſhould be a little regarded in the compoſition.

2. No queſtion that can be anſwer'd two ways ſhould be allowed of, which will neceſſarily lead ſome from the expected anſwer.

3. Nothing that is very paradoxical, much leſs naturally impoſſible, and void of demonſtration, ſhould be put for an arithmetical queſtion.

4. No ambiguous or doubtful words ſhould be uſed, but ſuch as are plain and eaſy to be underſtood.

5. We

5. We ſhould uſe the ſame terms of art with the late and beſt authors; or at leaſt our terms and phraſes ſhould be ſo plain and eaſy, as that none may be miſtaken or deceived by them: for I think it is much better and more improving, to invent ſomething ingenious than abſtruſe. Nor do I ſee any great benefit or difficulty in puzzling mankind, and racking their brains; nor is it neceſſary, when there is ſuch an infinite variety in the mathematics of pleaſant and profitable propoſitions. All kind of learning is difficult enough, eſpecially the mathematical, to take up the ſhort interims of our time, without being made more tedious and laborious; therefore we ſhould make it our chief aim to facilitate and abridge it.

T. FLETCHER.

Of the Eclipſes in 1724.

1. Moon eclipſed, Monday, April 27, 8 morn. inviſible.

2. Sun eclipſed on Monday the 11th of May, at half an hour after 6 in the evening, almoſt total, and viſible. This will be the greateſt eclipſe that will happen in England for theſe 50 years.

The general eclipſe (in reſpect to the meridian of London) begins at 52 minutes paſt 2; the central ſhadow enters on the earth in lat. 13° 56′, in long. 226° 46′; whence it proceeds with a velocity of about 40 miles in a minute north-eaſtwards, along the weſt ſea, and over California, Nova Granada, and the northern parts of America, toward Terra Arctica, and Hudſon's Bay, where it tends towards the eaſt, and paſſeth Terra Cunadenſis, by Nova Francia, the Gulph of St. Laurence to Newfoundland; then traverſes the north ſea to Europe, enters France about St. Malo, and proceeds along by Le Mans Blois, Bourges, and Challon-ſur-ſoane, and having paſs'd through the north parts of Italy, by Geneva, and borders of Switzerland, over the Alps, by Palanza, Como, and Breſcia, it leaves the earth between Mantua and Rovigo.

J. Willingham.

Mr

Mr. *Joseph Smith*, of Fleet in Lincolnſhire, from a geometrical conſtruction and a calculation, ſends the following account of the ſun's eclipſe at Holbeach: begins 5 h. 41′, mid. 6 h. 37′, end 7 h. 29′. At Stockholm in Sweden, begin 6 h. 51′, mid. 7 h. 42′, ends 8 h. 27′. Digits eclipſed 8 12 ſouth. At Bermudas in the Weſt Indies, begin. 12 h. 43′, mid. 1 h. 43′, ends 2 h. 33′. Digits 3 north.

In lat. 2° 48′ north long. 132° 30′ weſt, at 5 h. 55′, the eclipſe will begin at the ſun's riſing. Lat. 13° 50′ north long. 151° 18′ weſt from Holbeach, in the ſouth ſea, the ſun will be centrally eclipſed as he riſeth.

Lat. 51° 48′ north long. 89° 47′ weſt, at 11 h. 19′, the ſun will be centrally eclipſed in the 90th degree at Canada, or New France in America.

In lat. 54° 19′ long. 82° 47′, part of Hudſon's Bay, the ſun will be centrally eclipſed in the meridian.

In the lat. 45° 16′ long. 11° 50′, parts of Mantua in Italy, the central eclipſe will end. In lat. 34° 48′ north long. 10° 31′ weſt, the Atlantic ocean near Gibraltar, the eclipſe ends.

☉ Eclip. 11 May, 1724, even.		Beg.	Mid.	End	Dig.
		h. ′			
By Aſtron. Carol.	Coventry	V 38	VI 34	VII 26½	XI 31
Mr. Chattock	London	5 39	6 36	7 23	12 7
	Coventry	V 32	6 29	7 23	12 0
Dr. Halley	London	5 39	VI 35½	VII 27½	— —
Mr. Richards	Exeter	5 25	6 18	7 11	12 2
Mr Smith	Holbeach	5 41	6 37	7 29	11 30
. . . .	London	5 38	6 35	7 29	11 47
Mr. Willingham	Myton York	5 36	6 30	7 22	11 5
Mr. Gill	Worceſter	5 31	6 27	7 20	11 51
Mr. Child	Northampt.	5 40	6 36	7 28	11 30
Mr. Williams	Oxon	5 35	6 31	7 23	— —
Mr. Warner	Wellingbor.	5 39	6 36	7 29	11 37
Mr. Leadbetter	London	5 39	6 36	7 25	11 45

This eclipſe will not be total, but at the greateſt darkneſs there will be a ſmall thread of light on the upper part of the ſun's body, juſt a 24th part of his diameter or breadth. But ſome of the ſtars will be diſcern'd. The planets ♂ in the ſouth-eaſt, ♄ nearer the ſouth, and ☿ on the left-hand, the ſun a little higher.

3. Moon

opposite

3. Moon eclipſed, October the 21ſt in the morning.*

	h.	Leadb.	J. Paint.
Beginning by Adraſtea's calcul.	II 30	2 52	2 33
The middle at — —	III 47	4 8	3 52
The end at — — —	V 4	5 24	5 16
Digits eclipſed north ——	7 16	7 4	6 12

4. Sun eclipſed, November 4, at 11 at night, inviſible.

New

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* This eclipſe was obſerved thus:

1. At *Gomroon* in *Perſia* by Mr. *W. Sanderſon.*

The moon entered into the dark ſhadow or umbra of the earth at 11 min. 33 ſec. paſt five, Ante Meridiem.

2. At *Rome* by *Blanchini.*

Temp. Ver.			
h.	m.	s.	
3	15	40	Initium umbræ veræ.
5	48	50	Finis umbræ veræ.

3. At *Liſbon* by *John Baptiſta Carbone*, and *Dominico Capaſſo.*

Temp. Ver.			
h.	m.	s.	
1	38	0	Penumbra incipit eſſe ſenſibilis.
1	47	45	Umbra incipit.
4	20	36	Finis eclipſis.
4	28	0	Deſinit penumbra ſpiſſior.

4. Other obſervations of the Solar eclipse in *Britain*, taken from the Diary for the next year (1725).

	Begin.	Midd. h. m.	End h. m.	Digits
At Wyken in Warwickſhire —	- -	6 31	7 28	11
By Mr. Lawry, Cornwall ——	- -	6 22	7 20	12
Mr. Tapper, Briſtol, continued in total darkneſs $2\frac{1}{4}$ m. —	- -	6 28	- -	12
Mr. Child, Newport Pagnel —	5 40	6 35	- -	-

New Questions.

I. *Question* 105, *by Mr.* Williams.

When fam'd Europa's ſon, Minos the juſt,
Beſieg'd Megæra's tower with his hoſt,
Whoſe ſounding walls, moted around, did ſtand,
Erected by Apollo's ſacred hand.
This Niſus held, whoſe purple hair, 'tis ſaid,
Contain'd their ſafety, till it was betray'd
To Minos, by his daughter's am'rous aid.
For whilſt ſhe view'd his practis'd chivalry
From off the tower, ſhe trembling thus did ſay:
" Inforc'd by love, this tower I intend,
" To render up, and give theſe wars an end.
" Did not Petrea's daughter, with like flame,
" Venture like hazards for Amphitryo's name?
" Then why ſhould Scylla leſs advent'rous prove?
" Love conquers all things; all muſt yield to love."
This ſaid (Pallas aſſiſting her) ſhe made
Of ropes a ladder, and by Cupid's aid
Convey'd it to her love upon the ſhore,
Who it aſcends, and ſo he gain'd the tower.
Now you'll expect, ſince I'm hiſtorian grown,
The tower's height; and that may thus be known:
For if 'tis multiply'd by * ninety-three, * 93 feet
The breadth o'th' moat, and the product added be
To twice the ladder's length, 'twill make theſe feet,
Fourteen thouſand four hundred twenty-three, compleat.
[14423

II. *Question* 106, *by Mr.* John Richards.

Being taking a glaſs with ſome friends of the town,
The exciſeman came in, whom we aſk'd to ſit down;
He did ſo, and as we did freely converſe,
Our new friend began the following diſcourſe.
" That ſpheroidal caſk (ſays he) on that ſtiller,
" Is more artfully made than any i'th' cellar;
" For whether you work by Mr. Oughtred's canon,
" Or multiply the difference by ſeven-tenths (as is common
" For us gaugers, when haſty, to do in the caſe)
" 'Twill bring out the ſame equal cylinder's baſe.
" The length of the caſk's forty inches five-tenths,
" And ninety-eight gallons I make the contents."

The

The veſſel lay level, the bung being up,
The liquor was eleven inches deep from the top.
I aſk'd if he knew how to ullage the caſk,
Alack, ſir, ſays he, that's no very hard taſk.
I queſtion'd his ſkill; this nettled the gauger,
Who preſently offer'd to lay me a wager,
That he'd tell to a ſpoonful the liquor's content:
'Tis done, ſir, (ſays I) for a crown to be ſpent.
He conſulted ſuch authors as merit regard,
For the ullaging part; as Hunt, Jones, and Ward.
And having gone thro' with the whole operation;
I found none of his methods would bear demonſtration:
So demanding the crown, he refuſes to pay,
Till I ſhew him a more mathematical way.
Now for ſake of the gains, I'd ſoon do't if I could,
But ſeeing I cannot, I beg that you would.

III. *Queſtion* 107, *by Mr.* A. Naughley.

Fair ladies, of you I muſt yet enquire
How the poll ſtood for the knights of our ſhire.
The number of voices, as I have ſeen,
Was five thouſand two hundred and nineteen.
Which among four was juſt ſo divided,
As one the ſecond and third exceeded
By twenty-two and fourſcore bating ſeven,
The fourth by no more than ſixſcore and ten:
Then how many votes had each candidate;
You can't in finding much trouble your pate,
But yet I'd have a general rule for that.

IV. *Queſtion* 108, *by Mr.* Richard Whitehead.

Suppoſe four brothers repreſented be
By theſe four letters, *A*, *B*, *C*, and *D*;
And each of them unequally to ſhare *perches*
A right-lin'd field, in form triangular; $65\frac{1}{2}$
Two ſhorteſt ſides of which the page does ſhow, $52\frac{89}{550}$
But for its baſe, it's what I do not know.
An oblong does poſſeſs the middle ſpace,
Touch'd by two ſides, and lying on the baſe,
Whoſe length in perches is in margin ſeen, $46\frac{272}{275}$
And its breadth, or height, is juſt eighteen:
The other ſhares do in each angle lie,
And their contents are what you're to deſcry.

C takes the oblong, being the greateft fpace;
B takes the angle oppofite the bafe;
A's on the left, *D*'s on the right does fall;
He being youngeft, had the leaft of all.
I, who have ever loving prov'd and true,
Do for your anfwer, ladies, humbly fue.

V. *Queftion* 109, *by Mr.* Wm. Doidge.

One fummer evening, as I walk'd alone,
I heard a damfel making piteous moan:
I afk'd this fair the caufe of fo much grief,
If I cou'd give her troubled mind relief.
With fighs and tears fhe did her cafe explain;
'Oh! cruel love's the caufe of all my pain.
'A fpark, in whom external beauty fhin'd,
'Hath won my heart, hath ftole away my mind:
'That we fhou'd wed my father gave confent;
'To live in joys and pleafures permanent.
'But ah! that happy day it muft not be,
'Till this equation * and my age agree.
'All ways we've try'd, but all our labour's vain,
'To know my age, and cure me of my pain.
'‘Ceafe, ceafe, fair maid, your mournful tears, (faid I)
'To the ingenious ladies I'll apply,
'Whofe fkill in figures' feen i'th' diary.'
Ladies, confider love's tormenting pain,
Leave not this fair one longer to complain:
Tell her what age fhe will be made a bride,
When fhe'll be happy by her lover's fide.

$$* \frac{\sqrt[2]{aaa} - \sqrt[3]{aa}}{4{\cdot}962} = a = \text{her age.}$$

VI. *Queftion* 110, *by Mr.* George Brown.

Upon the northern feas, where boift'rous ftorms did rife,
And darkfome clouds obfcur'd the azure fkies,
And from our fight all its celeftial bodies fkreen,
That day or night to us could not be feen.
During which time, our gallant fhip was tofs'd
'Midft rocks and fands, each minute caft for loft,
Where every billow did prefent a grave,
And death triumphant rode on ev'ry wave.
When in the height of forrow, fear, or doubt,
The ftorm allay'd; and to our joy bright Sol look'd out;

Whofe

Whose altitude was taken in the heav'n,
And prov'd thirty-nine degrees, and minutes sev'n.
The calm continu'd, and in that very place
We stay'd an hour and fifty minutes space;
And then bright Phœbus smil'd on us once more,
His altitude again we did explore. 55° 57′
By our accounts, we found that very day
Fell out exactly on the tenth of May.
Now, ladies fair, whose wits are ripe at will,
In this distress, I pray exert your skill;
And from what here is found, gave me, I pray,
The latitude o'th' ship, and hours o'th' day.

The Prize Question, by Adrastea.

When poets feign Atlas the world cou'd bear,
And giant great Goliah wield the spear:
Prodigious bulk! And Archimedes move,
With his machine, the lofty seat of Jove.
We stand amaz'd, when they such things rehearse,
About the vast expanse o'th' universe.
Geographers do little less pretend
The faults and errors in the globe to mend:
Will all its parts, seas, creeks, and bays unravel,
Tho' they no farther than their garrets travel.
I only have one county measur'd over,
It's hard enough all parts for to discover;
With curious theorms by old Euclid shown,
And instruments as heretofore unknown.
At the intersection of two Roman ways,
Cut thro' this kingdom in their Cæsars days,
And by them nam'd the Watling-street and Fosse;
There stood Bennones, which now we call High Cross.
From thence (nearly) in a straight line I come
Unto Dove Bridge, or fam'd Tripontium;
Bearing almost south east by south: The whole
Was just eight mile, one furlong, and five pole.
To Eathorpe I perambulating go,
The line is perpendicular I know;
But turns and windings, till the Fosse I met,
Will not its horizontal distance get.
In a straight line the Fosse I measur'd, till
I reach'd a tumulus call'd Brinklow-hill:
Designing once again High Cross to view,
And by my clock-work found I'd measur'd true,
Eight miles, seven furlongs, and poles twenty-two:

Tripontium then was juſt within my ſight,
A line drawn to it made an angle right:
With this perpend. and what before I've ſhown,
The triangle compleatly may be known.
  From Tripontium the river Avon I ſurvey'd,
Which many curious turns and windings made.
Cloſe by ſtands Newbold, eminently high,
Whence thoſe three places mention'd I cou'd ſpy:
'Twixt firſt and ſecond, the angles eighty-eight,
Fifteen: Eathorpe from the bridge call'd Dove, $88° 15'$
One hundred forty-nine, and forty-five did prove. 149 45
From Eathorpe to Bennones, of conſequence
One hundred twenty-two degrees: From hence 122 0
I cou'd adjuſt the diſtance to each place,
And tell if Avon truly meaſur'd was.
  This to Geodeſian's ſeldom known;
Now tell the theorems by which they're ſhown.

1725.

Queſtions anſwer'd.

* I. Queſtion 105 anſwer'd by Mr. John Painter.

LET $b = 93$, c = ladder's length, a = tower's height. Then is $ab + 2c = 14423$ per queſtion, and $aa + bb = cc$, 47 Euc. 1. There will ariſe this ambiguous equation $a = \frac{1}{2}d + \sqrt{\frac{1}{4}dd - z} = 151{\cdot}2688$ the tower's height; and the ladder's length $= 177{\cdot}57$.

II. Queſtion

* I. QUESTION 105.

The ladder being the hypothenuſe of a right-angled triangle, whoſe baſe is the breadth of the mote, and perpendicular the height of the tower; if b be put $= 93$ the breadth of the mote, and $x =$ the height of the tower, we ſhall have $\sqrt{b^2 + x^2} =$ the ladder; and then $bx + 2\sqrt{b^2 + x^2} = 14423 = c$ by the queſtion; which equation being reduced and a put $= b^2 - 4$, we have $x = \frac{bc - 2\sqrt{ab^2 + c^2}}{a}$.

* II. *Question* 106 *answer'd by Mr.* John Knipe.

The bung diam. 32·1152 } inches for { 29·066 } inches for
The head diam. 23·3168 } ale gall. { 21·103 } wine gall.
The ullage wine gall. { 32·672, 65·327 Ale gall. { 28·018 dry. 69·981 wet.

The same answer'd by Mr. Rich. Tapper.

Let H = the head diameter, B = bung, D the difference = $B - H$. By Mr. Oughtred's theorem $\sqrt{\frac{2BB + HH}{3}}$ = the diameter of an equal cylinder.

But

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* II. QUESTION 106.

Putting b and h for the bung and head diameters; by Oughtred's rule $\sqrt{\frac{2b^2 + h^2}{3}}$ = the mean diameter = (by the other method mentioned in the question) $\frac{b - h}{10} \times 7 + h = \frac{7b + 3h}{10}$; from this equation is found $h = \frac{53}{73}b$; that is the bung and head diameters are exactly in proportion as 73 to 53.——Now let $73z$ and $53z$ be the two diameters; then, supposing the content 98 ale gallons, $\frac{2 \times \overline{73z}|^2 + \overline{53z}|^2}{1077 \cdot 157} \times 40 \cdot 5 = 98$; hence $z = \sqrt{\frac{98 \times 1077 \cdot 157}{40 \cdot 5 \times 2 . 73^2 + 53^2}} = \cdot 4399361$, and consequently the two diameters $73z$ and $53z$ are 32·11535 and 23·31662.

Then for the ullage of the cask, it may be *truly* found by the rule in Cor. 2 page 290 Mensuration. Or, to use the approximating rule given at page 545 of the same, $\frac{11}{32 \cdot 11535} = \cdot 3425155$; the circular segment answering to this quotient is ·23785866; then ·23785866 $\times \frac{98}{\cdot 7854} = 29 \cdot 68$ gallons = the ullage nearly.

But, $\cdot 7B + \cdot 3H =$ the diameter of the equal cylinder per queſtion; by involution, tranſpoſition, and diviſion, we have $BB - \frac{126}{53}HB = -\frac{73}{53}HH$, and $HH - \frac{126}{73}HB = -\frac{53}{73}BB$. Hence $B = \frac{73}{53}H$; and $H = \frac{53}{73}B$.

Wherefore it will be as $53 : 73 :: H : B$, and the contrary, univerſally: and the diameters 21·103 and 29·066 for wine gallons, or 23·316 and 32·115 for ale.

Let $x = \frac{1}{2}$ difference of the wet and dry inches, $b = \frac{1}{2}$ bung diameter. Then $2\sqrt{bb - xx} =$ the breadth of the ſurface of the liquor in the middle of the caſk; and multiplying by $\dot{x}$, the fluent will be $2bx - \frac{x^3}{3b} - \frac{x^5}{20b^3} - \frac{x^7}{56b^5} - \frac{5x^9}{576b^7}$ — &c. = the area of the middle ſegment of a circle to the radius b, and the chord lines diſtance from the center in the bung diameter x.

Now to find the length of the radius at any diſtance from the bung diameter:

Let $a = \frac{1}{2}$ length of the ſpheroid, $l = \frac{1}{2}$ length of the caſk, $h =$ head diameter. Then $aa : bb :: \overline{a+l} \times \overline{a-l}$ $(aa - ll) : hh$, hence $aahh = aabb - llbb$; put $c = bb - hh$, then $aa = \frac{llbb}{c}$. Let $z =$ the diſtance of the circle from the bung diameter whoſe radius is ſought. Then $\frac{llbb}{c}$: $bb :: \frac{llbb - czz}{c} : \frac{llbb - czz}{ll} =$ the ſquare of the radius; which rais'd to the $\frac{1}{2}$ power, it will give the radius $= b - \frac{czz}{2bll} - \frac{ccz^4}{8b^3l^4} - \frac{cccz^6}{16b^5l^6} - \frac{5c^4z^8}{128b^7l^8} - \frac{7c^5z^{10}}{256b^9l^{10}}$ &c. which rais'd to its ſeveral powers, and ſubſtituted in the room of b, it will give the area. The ſeries multiplied by the fluxion of z, gives the ſolidity or quantity of liquor. Then find the fluent of each term, and let $l = z$, the ſeries will ſhew $\frac{1}{4}$ of the difference of the wet and dry parts; or, if $l =$ the whole length, gives the $\frac{1}{2}$ difference, which added or ſubtracted with the contents, ſhews the quantity of liquor in the caſk, 65·5541 vacuity, 32·4458 wine gallons.

III. Queſtion

* III. *Queſtion* 107 *anſwer'd by* Sylvia.

The ſum of any whole quantity and the exceſſes of its greateſt part above each of the other, being divided by the number of parts, gives the greateſt, and thereby all the other parts. Hence the firſt had 1361, the ſecond 1339, the third 1288, and fourth 1231 votes.

† IV. *Queſtion* 108 *anſwer'd by Mr.* A. Naughley.

Let $b = 65{\cdot}5$ perches, $c = 52{\cdot}16$, $d = 46{\cdot}98$, $p = 18$; a, e, o, u, y, = ſeveral ſegments of the lines in the triangle. Then $ee - yy = uu$, $aa - dd + 2dy - yy = uu$, $cc - 2ce + ee - oo = pp$, by 47 Euc. 1; $c : e :: b : a$, by 2 Euc. 6; and $o + y : c :: y : e$, by 4 Euc. 6: whence this equation $\frac{bb}{cc}ee - ee + \frac{2de}{c-e}\sqrt{cc - pp + ee - 2ce} = dd = 2077{\cdot}9612$, which reduced and extracted, gives $e = 28{\cdot}32$; conſequently $a = 35{\cdot}36$, $o = 15{\cdot}63$, $y = 18{\cdot}56$, $u = 21{\cdot}39$, and the whole baſe $86{\cdot}539$.

	A.	R.	P.		A.	R.	P.
A's ſhare =	1	1	16	*C*'s ſhare =	5	1	5
B's —— =	3	0	20	*D*'s —— =	0	3	21

V. *Queſtion*

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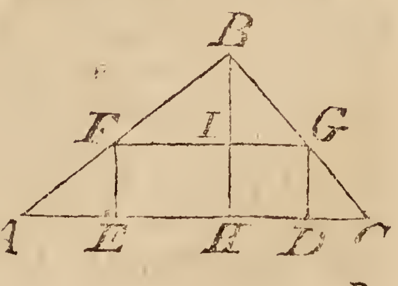
* III. QUESTION 107.

The rule mentioned in the original ſolution above, is thus diſcovered: Let the ſum s be divided into n parts, of which the differences between the greateſt and each of the reſt are a, b, c, d, &c. Then if x be the greateſt, $x - a$, $x - b$, $x - c$, $x - d$, &c. will be the others; and their ſum $x + \overline{x-a} + \overline{x-b} + \overline{x-c} + \overline{x-d}$ &c. or $nx - a - b - c - d$ &c. $= s$; hence $nx = s + m$, putting m for the ſum of the differences, and $x = \frac{s+m}{n}$ = the greateſt; which is the rule.

† IV. QUESTION 108.

The original ſolution may be explained by this figure, in which $EFGD$ is the rectangle inſcribed in the propoſed triangle ABC, and BH perpendicular to AC; then the notation makes $b = AB$, $c = BC$, $d = FG$, and $p = EF$; alſo $a = FB$, $e = BG$, $o = DC$, $u = BI$, and $y = GI = DH$; and hence the equations and proportions in the ſolution are evident.



But

* V. *Question* 109 *answer'd by Mr.* Tapper.

Given $a^{\frac{3}{2}} - a^{\frac{2}{3}} = 4\cdot962\,a = b\,a$ to find a. Let $x^6 = a$; then $x^{18} = aaa$, and $x^{12} = aa$, also $x^{\frac{18}{2}} - x^{\frac{12}{3}} = bx^6$, which when contracted is $x^9 - x^4 = bx^6$, and by transposition and division $x^5 - bx^2 = 1$. Here x will be found $= 1\cdot7425615449$ +, and $x^6 = a = 27\cdot9981125 =$ 27 years, 364 days, 13 hours and ½ *fere*, or 28 years *proxime*.

† VI. *Question* 110 *answer'd by Mr.* Nat. Browne.

The latitude 46° 33′, the hours 8 h. 24 m. and 10 h. 15 m. *The*

But the solution will be simpler thus: Put b, c, d, and p for AB, BC, FG, and GD respectively, as in the original solution; and $\frac{AB}{BF} = \frac{BC}{BG} = \frac{AC}{FG} = x$: and hence $dx = AC$, and $BG = \frac{c}{x}$. Then $dx : b + c :: b - c : \frac{bb - cc}{dx} = AH - HC$; hence $CH = \frac{dx}{2} - \frac{bb - cc}{2dx} = \frac{ddxx - bb + cc}{2dx}$; and then $BH^2 = BC^2 - CH^2 = c^2 - \left(\frac{ddxx - bb + cc}{2dx}\right)^2 = \frac{4b^2c^2 - \overline{d^2x^2 - m^2}^2}{4d^2x^2}$, by putting m^2 for $b^2 + c^2$. Again, $CG : GD :: CB : BH = \frac{px}{x - 1}$. Consequently $\frac{4b^2c^2 - \overline{d^2x^2 - m^2}^2}{4d^2x^2} = \left(\frac{px}{x - 1}\right)^2$; from which equation x is found $= 1\cdot85$ nearly, and hence the other quantities all become known.

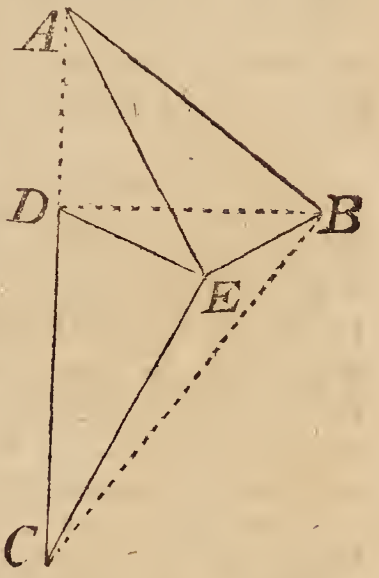
† VI. QUESTION 110.

Here are given two observed altitudes of the sun (supposed to be freed from the errors of refraction), with the (supposed) true interval of time between the observations, as also the declination of the sun; to find the latitude and true times of observation. It is admitted that the watch or time-keeper may be too fast or too slow, but yet however it is supposed to go true for the interval of time between the observations. The declination for the supposed middle true time between the times of observation, may be used for the common declination at both times, unless the interval of time be great; but if this be thought not sufficiently accurate, let the declinations be taken for the two supposed true times themselves, and used in the calculation.

Con-

The Prize Question answer'd.

In the first part of the question there is given in a right-angled triangle ABC, the cathetus AB, and the alternate segment of the hypothenuse CD, (made by a perpendicular BD, let fall from the right angle;) to find the other segment DA. Put $c = AB$, $b = CD$, and there will arise this theorem, $a = \sqrt{cc + \frac{1}{4}bb} - \frac{1}{2}b = 4{\cdot}81903$, and by 47 Euc. 1, the base $= 11{\cdot}0836$, the perpendicular $DB = 6{\cdot}55$; which compleats the triangle.



Then

Construction.

On a proper plane, as a primitive, describe the triangle $OP\odot$, making $\odot P$, OP equal to the co-declinations for the two times, and the angle at P equal to the given interval of time; then will P be the pole, and $\odot$, O the places of the sun at the first and second observations. Again, about the poles $\odot$, O describe two circles at the distance of the two observed co-altitudes and intersecting in Z the zenith of the place. Then a great circle described through P, Z will be the meridian, the arc $PZ =$ the co-latitude, and the angles $ZP\odot$, ZPO the measures of the times required.

Calculation.

Drawing the great circles ZO, $Z\odot$. In the triangle $OP\odot$ are given the two sides OP, $\odot P$ equal the two co-declinations, and the included $\angle OP\odot =$ the interval of time; to find $O\odot$ and and the $\angle O\odot P$. Then in the triangle $OZ\odot$, are known the three sides; to find the $\angle O\odot Z$; which taken from the $\angle O\odot P$, there remains the $\angle Z\odot P$. Lastly, in the triangle $Z\odot P$, are known the two sides $Z\odot$, $\odot P$, and included $\angle Z\odot P$; to find the side PZ the latitude, and the $\angle ZP\odot$ the time for the first observation from noon; from which taking the given difference $OP\odot$, there remains the time of the second observation from noon.

Then from E where Newbold ſtands, there is given the angle AEB 88° 15′; BEC 149° 45′; and CEA 122°. To find the diſtances EA, EB, EC, and ED. And here we muſt note, as in the anſwer to queſtion 100, that as any two of the angles given, together exceed 180 degrees, the point where Newbold ſtands will fall within the triangle ABC.

Now if you ſuppoſe a circle to paſs through C Eathorpe, E Newbold, and B Tripontium, and biſect the line CB, producing that biſection through the center of the circle, it will cut the periphery in a point, from whence lines drawn to B and C, will compleat a tripezia inſcrib'd in a circle; which by 22 Euc. 3, has the two oppoſite angles taken together equal to two right angles: hence the angle at the periphery will be 30° 15′. In like manner proceed with the 3 points AEB, and the angle at the periphery will be 91° 45′.

Then if from the center of the firſt circle you draw lines to B and C, the angle contained between them will, by 20 Euc. 3, be double to that at the circumference, viz. 60° 30′, and in the other circle it will be 183° 30′.

But it will be needleſs to explain the matter any farther, having already, in the laſt year's diary, given as clear a demonſtration as could be, without a large ſcheme that would admit of all thoſe lines and circles requiſite thereto; what remains being purely trigonometrical, from whence I have deduced this followig anſwer.

						Tapper.		
			M.	F.	P.	M.	F.	P.
Given	From High Croſs to Tripontium	AB	8	1	5	8	1	5
Given	From Eathorpe to Brinklow	CD	8	7	22	8	7	22
	To complete the triangle —							
	Brinklow to High Croſs —	DA	4	6	22	4	6	21
	Tripentium to Eathorpe —	BC	11	0	32	11	0	29
	Brinklow to Tripontium —	DB	6	4	16	6	4	20
	Eathorpe to Bennones —	CA	13	6	4	13	6	3
Newbold to	High Croſs —	EA	7	4	24	7	4	26
Newbold to	Tripontium —	EB	3	2	2	3	2	1
Newbold to	Eathorpe —	EC	8	1	16	8	1	11
Newbold to	Brinklow —	ED	4	1	16	4	1	20

Mr. Rich. Tapper *anſwers in the manner following.*

Let a = the diſtance of Tripontium and Eathorpe; c = the diſtance of Tripontium and High Croſs = 2605 poles; n = the diſtance of Brinklow from Eathorpe = 2862 poles; then $a = \sqrt{\overline{ccnn + \frac{1}{4}n^4}}\big|^{\frac{1}{2}} - \frac{1}{2}nn = 3549.9109$ poles; which call d. Let s = ſine of 30° 15′; m its coſine, or ſine of 149° 45′; z = the ſine of 88° 15′, x its coſine, 1 = radius.

Imagine

Imagine the line which joins Newbold and Tripontium to be extended through the fosse, and a perpendicular let fall from Eathorpe upon it; also a perpendicular from High Cross upon the said line. Then $d : s :: a : \frac{as}{d}$ = the sine of the angle made by the lines which join Tripontium and Newbold, and Tripontium and Eathorpe, $1 : a :: \frac{as}{d} : as$ = the length of the first perpendicular, $1 : d :: m : ma$ = the distance from Newbold to the place where the said perpendicular cuts the extended line; and $\sqrt{dd - aass} - ma$ = the distance of Newbold from Tripontium, by 47 Euc. 1. Now $\frac{\sqrt{dd - aass}}{d}$ = the cosine of $\frac{as}{d}$. Then, $z : c :: \frac{\sqrt{dd - aass}}{d} : \frac{c}{zd}\sqrt{dd - aass}$ = the distance from Newbold to High Cross; $1 : \frac{as}{d} :: c : \frac{cas}{d}$ = the distance from Tripontium to the place where the perpendicular from High Cross would cut the line between Newbold and Tripontium, and $1 : c :: \frac{\sqrt{dd - ssaa}}{d} : \frac{c}{d}\sqrt{dd - ssaa}$ = the perp. also $z : \frac{c}{d}\sqrt{dd - ssaa} :: x : \frac{xc}{dz}\sqrt{dd - ssaa}$ = the distance of the perpendicular from Newbold. Hence this equation, $\overline{1 - \frac{xc}{dz}} \times \sqrt{dd - ssaa} = ma + \frac{sca}{d}$, which reduced gives this theorem $a = \dfrac{d - \frac{cx}{z}}{\sqrt{\overline{\frac{cs}{d} + m}\big|^2 + \overline{s - \frac{scx}{dz}}\big|^2}}$ = 2612·7383 poles.* *Q. E. I.*

Of

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* *The* PRIZE QUESTION.

This question will be constructed thus:

Construction.

In the first place we have given, in a right-angled triangle, one leg AB, and the alternate segment CD of the hypothenuse made by the perpendicular BD; and the triangle will be constructed as question 28 page 84. Again, the point E, where the three lines AE, BE, CE make given angles with each other, will be determined as in question 100 page 242.

Of the Eclipſes in 1725.

There will be ſix eclipſes this year: Four times will the moon's dark body interpoſe between the ſun and earth, and hide his face; and twice will the earth interpoſe, and hinder the ſun from enlightening the moon: but of theſe only one of the moon will fall upon our part of the globe.

1. Sun eclipſed, the 2d of April, at 2 in the morning, inviſible.

2. Moon eclipſed, the 16th of April, at 9 morning, inviſible.

3. Sun eclipſed, 1ſt of May, at 10 forenoon, inviſible.

4. Sun eclipſed, 25th of September, at 7 morning, inviſible.

5. Moon eclipſed, on Sunday the 10th day of October, at 7 o'clock in the evening, total and viſible.*

	Begin h. m.	Begin tot. d.	Midd.	End total	End	Dura	Dig.
Aſtronom. Coventry	V 10	VI 7	VI 56	VII 4	42	3 31	21 56
Chattock, London	5 13	6 12	7 4	7 56	8 55	3 41	22 33
Child, Newport	5 28	6 26	7 14	8	59	3 32	21 36
Turner, Hull	5 15	6 9	6 55	7 41	8 36	3 20	
Leadbetter, London	5 29	6 27	7 1[illegible]	8 3	9 1	3 32	21 36
Sparrow, Nottingham	5 51	6 4	6 53	7 43	8 41	3 35	22 0

6. Sun eclipſed, 24th of October, at 11 at night, inviſible.

New

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* This eclipſe was obſerved

1. At *Albano* by *S. Fr. Blanchini.*

h.	m.	
6	45	Total Immerſion.
8	20	Emerſion
9	25	The End.

2. At *Briſtol* by *Jer. Burroughs*, Eſq.

App. Time

h.	m.	s.	
7	31	20	Emerſion or beginning of light.
8	29	30	End.

New Questions.

I. *Question* 111, *by Mr.* Rich. Whitehead.

In ſome company lately, mathematical fellows,
By the ſide of a pond which flow'd hard by an alehouſe,
I began to be pert with my angles and ſquares,
With my areas, my baſes, my cones, and my ſpheres;
(For to talk of old Euclid, you muſt know I am prone,
And when out of his elements, am out of my own;)
When ſays one that ſat next me, hold, prithee a word,
I'll hold you ten ſhillings for the good of this board,
Your don't tell me how far croſs the water 'tis wide,
From the place where we ſtand to that tree on this ſide,
And what ſpace does each of theſe objects divide.
From the boat which now lies on the oppoſite ſhore,
With my ſquare and a line (for they'd grant me no more)
I meaſur'd in yards, as by figures you ſee, $147\frac{3}{4}$
From beyond the ſaid houſe, ſtrait with it and the tree.
Then ſquare from this line I immediately went,
Or a right angle made, the page ſhews the content, 475
Till the boat and the tree were exact in one line;
Then I meaſur'd five hundred yards ſeventy and nine, 579
Quite up to the boat! then I, ſtrait with the houſe,
From the tree meaſur'd yards, as the page fairly ſhews; 259
The meaſure I took ſquare from thence you muſt note, $507\frac{1}{3}$
Till I'd brought the ſaid houſe in a line with the boat:
Then up to the boat to make matters more clear,
I meaſur'd thoſe yards which in margin appear. $674\frac{1}{3}$
To finiſh my working, what made me the quicker,
Was, I thought I cou'd do't, and make ſure of the liquor;
But my boaſted rules fail'd me, nor with all my deep ſearches
Cou'd I find out the diſtance, with its roods and the perches.
So ladies, I beg, for you're nice at diſcerning,
You'd untie this hard knot, which has puzzl'd my learning.

II. *Question* 112, *by Mr.* Tho. Dod.

A wretch who ſcorn'd to uſe th' appointed means
Heav'n's bliſsful courts to reach, on's own thus leans;
Who, by mechanic art, a ladder rais'd
So high, it almoſt all mankind amaz'd.
Thus Jacob did, ſays he, and why may'nt I
Scale heav'n as well as he? at leaſt I'll try.
Wrapp'd in the clouds his head ſecurely lies,
And ſeems inviron'd with the azure ſkies;

From which, 'tis ſaid, a fire-ball falling down,
Let off a cannon at the baſe, whoſe ſound
Approach'd the ear at top in the ſame time
The fire-ball fell from ladder ſo ſublime.
Tell me, ye fair, if he to heav'n was got,
Or how far ſoaring from this earthly ſpot.

III. *Queſtion* 113, *by Mr.* Tho. Grant.

A father, dying, left three daughters fair,
To whom he gave five thouſand pounds a year,
On ſuch conditions as did them engage
To have their ſhares proportion'd to their age;
But of their ages all that can be known,
To effect the purpoſe is here under ſhown.
If to each daughter's age when ſquared you
Add the rectangle of the other two,
Theſe * numbers will expoſe themſelves to view.
Now ladies fair, I pray exert your ſkill,
And tell them how to ſatisfy the will.

* 1000, 980, 920.

IV. *Queſtion* 114, *by Mr.* Chriſt. Maſon.

When mighty Jove this world immenſe did frame,
And beauteous form from dark confuſion came,
No ſooner he his fiat did diſplay,
But the crude maſs of atoms all obey;
Each to their center with full ſpeed did haſte,
And dawning light peep'd o'er the gloomy waſte:
Then boundleſs æther its expanſion made,
And the foundations of the heavens were laid.
For homogeneous matter was compact,
And earthly atoms into form did act:
The humid vapours into ſeas were made,
Which did the borders of the earth invade.
The groſſer air around 'em both was ſpread,
Like a ſoft cov'ring to a nuptial bed.
Plants, fruits, and flow'rs receiv'd their genial birth,
And ſprung with vigour from the pregnant earth.
Then ſtraight was huſh'd the elemental wars,
And formed thence ſun, moon, and twinkling ſtars;
Then fiſh, and fowl, and beaſts for food or prey;
And laſtly man the whole for to ſurvey.
To contemplate and caſt his eyes above,
See with ſurprize the heav'nly bodies move,

And with delight the wand'ring planets trace,
Which thro' the zodiac move from place to place:
Their motions and their magnitudes compare,
And thence conclude how uniform they are;
How ev'ry one keeps in their proper ſphere,
And not, like mankind, ſtrive to interfere.
But ere our thoughts an aerial journey take,
Firſt let 'em here a ſuppoſition make;
That if a ball upon the earth ſhould weigh
Ten pounds in troy, and then cou'd it convey
To th' ſurface of each planetary ſphere;
I pray unfold what weight it wou'd be there?

V. *Queſtion* 115, *by Mr.* Bernard Annely.

Once on a lofty hill, whence ev'ry where
Around a glorious proſpect did appear;
There many fair and wond'rous works diſplay'd,
Of art and nature exquiſitely made:
Amidſt the various beauteous objects, I,
From far, a ſtately fabric did eſpy,
Rais'd on fair ground, that level ſtood with me:
Its height, I found, one hundred foot want three.
That time the ſun, going down, came in a line
Streight with the houſe and me; in height 'twas then
An hour's half quarter; by which the time did prove
Exact ſeven hours, and minutes fifty-five.
This on the firſt of June. Then, ladies, ſhew
The diſtance of the building to our view?

VI. *Queſtion* 116, *by Mr.* John Simmons.

An oblong cloſe of meadow ground,
That is by water compaſs'd round:
This by my paces I have found.
That the ſum of each ſide and end,
If to the diagonal be join'd,
Their total makes juſt half a mile.
I've purchaſed this cloſe (or iſle);
And muſt for it give, by bargain,
For each ſquare yard, a penny farthing;
But know not what is the whole ſum,
Which is the main thing to be known.
There's one I aſk'd knew well enough.
An old geodeſian gruff,

That lately did the ſame ſurvey:
Without large fees, no more he'd ſay
Than this, ' Leſs ſides or ends are in extreme
' Ratio; and the diagonal's the mean
' Or greater ſegment, and each ſide a mean to them.
' With theſe hints you may find the anſwer,
' I'm very buſy—pray be gone, ſir.'
Ladies, the ſides and purchaſe pray declare
In your diary, the next year:
Nor care a fig for the ſurveyor.

The Prize Queſtion.

With what vaſt ſpeed have all improvements run
Thro' all the ages ſince the arts begun.
Euclid's collections, full twenty centuries ſince,
Their mathematic knowledge may evince:
Archimedes the next age did produce,
Excelling all, was born in Syracuſe:
From him geom'try did much light receive:
Riſe of the globes and ſpheres to him they give:
The ſilver mix'd with gold in Hiero's crown,
By ſtatic art, he made the workman own.
Said, If he engine-footing had, cou'd move,
By force of ſcrews, the mighty ſeat of Jove!
When Marcellus laid ſiege to Syracuſe,
The Romans ſuffer'd, by his engine's uſe
In throwing ſtones; which ſhow'red from the ſky,
Like thunderbolts, the Romans to annoy.
But that great Roman ſoul ſtrict orders gave
In ſtorm and plunder, Archimedes to ſave.
But, curſed fate! by common ſoldier's hand
He's kill'd, whilſt poring on his ſchemes in ſand.
What mathematics ſuffer'd by ſuch blow,
Ah fruitful brain! ſtill ages want to know.
By curious theorems, he the diſtance knew
To the enemy, where the ſtones he threw:
Who viewing from a corner of the wall,
Which there run ſtraight, (an acute angle call)
Along the wall four hundred yards he pac'd,
Where he the warlike thund'ring engine plac'd:
Their camp to this line a right angle made;
Parallel to the wall's ditch, 'tis ſaid,
Whoſe length and diſtance is not known;
But to our purpoſe, ſomething hence is ſhown;
For at each ſtation, when the camp he ſpy'd,
It cut the ditch's ends, as both he try'd.

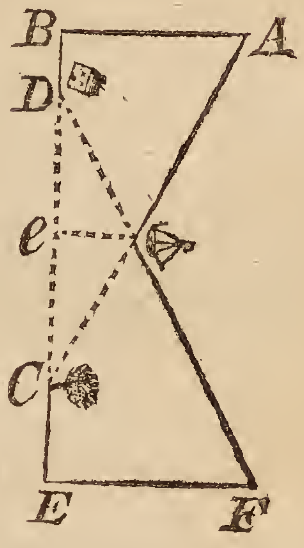
From

From the first station to the ditch, is found
Two hundred yards, measur'd along the ground.
From the enemy to the ditch's other end,
Two hundred sixty yards our hist'ries send.
Let's know the distance where Marcellus stands,
And a theorem answering our demands?

1726.

Questions answered.

The 111*th Question answer'd by Mr.* C. Mason.



Let 1 $BD = b = 147\frac{3}{4}$

2 $AB = c = 475$

3 $AG = d = 579$

4 $FG = f = 674\frac{1}{3}$

5 $EF = g = 507\frac{1}{3}$

and 6 $CE = h = 259$

put 7 $DF = a$

8 E.6. 8 $a : g :: a - f : \frac{ga - gf}{a} = Ge$

9 $c - \frac{ga - gf}{a} : d :: c : \frac{cda}{ca - ga + gf} = AC$,

for $c - g$ put x

9 In. 2 10 $\frac{ccddaa}{xxaa + 2xagf + ggff} - cc = BC^2$

10—1 11 $\sqrt{\frac{ccddaa}{xxaa + 2xagf + ggff} - cc} - b = DC$.

12 $\sqrt{aa - gg} - b = DC$

13 $\sqrt{\frac{ccddaa}{xxaa + 2xagf + ggff} - cc} - b = \sqrt{aa - gg} - b$

Which equation reduced, and the sums collected, &c. gives $a = 1078{\cdot}0833$: Then $a - f$ is the distance between house and boat $DG = 403{\cdot}7499$, and DC the distance between the house and tree $= 692{\cdot}2499$; and GC between the boat and tree $= 386$.* *Q.E.I.*

N.B. *The letter* G *is omitted at the boat in the preceding figure.*

II. *Question* 112 *answer'd by Mr.* Sam. Rouse.

Sound moves 1142 feet per second; heavy bodies fall $16\frac{1}{12}$ feet in the first second, according to Dr. Halley. Then put $a = 16\frac{1}{12}$, $b = 1''$, $x =$ ladder's height, $d =$ the time found flies $16\frac{1}{12}$ feet; $a : x :: bb : \frac{bbx}{a} =$ square descent of the ball. And $a : x :: d : \frac{dx}{a} =$ the time found moved

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* I. QUESTION III.

The final equation will be simpler by substituting x for the unknown perpendicular Ge, the known quantities being as in the original solution: for then, by similar triangles,

$$g - x : g :: f : \frac{fg}{g - x} = DF,$$

$$\text{and } c - x : c :: d : \frac{cd}{c - x} = AC;$$

hence, by right-angled triangles and subtraction,

$$DC = \sqrt{\frac{ccdd}{\overline{c - x}|^2} - c^2} - b,$$

$$\text{and } DC = \sqrt{\frac{ffgg}{\overline{g - x}|^2} - g^2} - h;$$

$$\therefore \sqrt{\frac{ccdd}{\overline{c - x}|^2} - c^2} - b = \sqrt{\frac{ffgg}{\overline{g - x}|^2} - g^2} - h.$$

And here if CE or h be supposed equal to BD or b, as those distances are arbitrary, and might as well be measured equal as unequal, then the final equation will become barely

$$\frac{ccdd}{\overline{c - x}|^2} - c^2 = \frac{ffgg}{\overline{g - x}|^2} - g^2, \text{ in which } x \text{ is easily found.}$$

moved to the ladder's top. Confequently $\frac{dx}{a} = \sqrt{\frac{xbb}{a}}$, whence $\frac{bbx}{a} = \frac{ddxx}{aa}$, $\because x = \frac{bba}{dd} = 81088{\cdot}085$ feet $=$ $27029{\cdot}36$ yards $=$ 15 miles, 2 furlongs, 34 perches, 7 feet.*

† III. *Queftion* 113 *anfwer'd by Mr.* John Turner.

Let $\left\{\begin{array}{l} aa + eu = b = 1000 \\ ee + au = c = 980 \\ uu + ae = d = 920 \end{array}\right\}$ by the queftion, then

$$\left.\begin{array}{l} +8u^8 - 18du^6 + 2bcu^4 - b^3uu + bbcc \\ \qquad\qquad + 18ddu^4 - c^3uu - 2bcd^2 \\ \qquad\qquad\qquad\qquad - bcuu + d^4 \\ \qquad\qquad\qquad + 5bcduu \\ \qquad\qquad\qquad - 7ddduu \end{array}\right\} = 0.$$

Which being collected and reduced gives the following numbers.

Ages.			Portions. l.	s.	d. f.
The eldeft	23·5276	cafh per annum	1784	19	$0\frac{1}{4}{\cdot}7568$
Second	22·7788		1728	2	$8\frac{1}{2}{\cdot}3738$
Youngeft	19·5991		1486	18	$2\frac{3}{4}{\cdot}8694$
		C. Mafon	5000	0	0 0

IV. *Quef-*

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* II. QUESTION 112.

The folution will be a little clearer thus: Putting $a = 16\frac{1}{12}$, $c = 1142$, and $x =$ the height. Then $\sqrt{a} : \sqrt{x} :: 1'' : \sqrt{\frac{x}{a}} =$ time of falling x feet; and $c : x :: 1'' : \frac{x}{c} =$ time of found's paffing over x feet; therefore $\frac{xx}{cc} = \frac{x}{a}$, and $x = \frac{cc}{a} = \frac{1142^2}{16\frac{1}{12}}$ $= 81088$ feet.

† III. QUESTION 113.

Various methods of folving this queftion may be feen in Wallis, Kerfey, and Ronayne.

* IV. *Question* 114 *anſwer'd by Mr.* Rich. Whitehead.

Supppoſe the ſun's parallax 10 ſeconds, and the magnitude of the earth according to Norwood's obſervations; then let $a =$ the diſtance of the earth from the ſun, $p =$ the periodical revolution of the earth, $s =$ the periodical revolution of one of ♃ ſatellites. To find its diſtance from ♃ ſay $p^2 : s^2 :: a^3 : \frac{a^3 s^2}{pp} =$ the cube of the diſtance ſought.

And as the ſquares of theſe periods recip. ſo are the centrip. forces towards their reſpective central bodies.

Then for the weight of bodies on their ſurfaces, if the diſtances are equal, the weight will be as the quantity of matter the bodies contain. If the quantities of matter are equal, the weights will be reciprocally as the ſquares of the diſtances: *Ergo*, If neither are equal, the weight will be in a compound ratio. For, as the diſtance between the ſun and earth, and the quantity of matter in the earth, is to ten pounds, ſo is the diſtance of Jupiter, and quantity of matter, to the weight ten pounds would weigh on his ſurface; and ſo for the reſt. Hence ten pound of our troy weight will weigh on the ſurface of the ſun 244 pound, on Jupiter 20, on Saturn 12·75, on the empire of the bedlamites, viz. the moon 3·45.

Mr. Alexander Naughley's *anſwer.*

On the ſurface of the ſun 240, ♃ 19·9, ♂ 6, ☽ 5·15, ☿ 2·15, ♀ 2·08, ♄ 17.

Mr. *Tho. Dod* computes them from

		☉	♃	♄	☽
Mr. Whiſton's numbers —	—	245	19·5	13·0	3·2
and Dr. Cheyne's theory	—	79·3	6·4	4·2	5

V. *Queſ-*

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* IV. QUESTION 114.

The proportions of the force of gravity at the ſurfaces of the planets, or the proportions of the weights of an equal quantity of matter at each, are now ſtated thus:

Sun	Moon	Mercury	Venus	Earth	Mars	Jupiter	Saturn
25	$\frac{1}{3}$	$\frac{1}{95}$	$\frac{4}{5}$	1	$\frac{1}{3}$	2	$1\frac{1}{3}$

Theſe being ſeverally multiplied by 10, we have

250	$3\frac{1}{3}$	$\frac{2}{19}$	8	10	$3\frac{1}{3}$	20	$13\frac{1}{3}$

for the weights required.

V. *Question* 115 *anſwer'd by Mr.* J. Turner.

The time was 7 h. 55′, and ⊙ ſetting in that latitude was 8 h. 2 m. 30 s. The longitude ♊ 21° 50′ 17″. Declination 23° 13′ 53″. Aſcenſional difference 30° 37′ 30″. To find the latitude, having the declination and aſcenſional difference, tan. declination 23° 13′ : radius :: s. aſcenſional difference 30° 37′ : tan. lat. 49° 52′ 53″. Then there are given two ſides and an angle included, to find the third ſide the coſine of the ſun's altitude 57′ 52″. Then s. ⊙ altitude : height of the object :: coſine of ſun's altitude : length of the ſhadow 5762·4 feet = 1920 yards.

VI. *Question* 116 *anſwer'd by Mr.* Whitehead.

Let a = oblong's greater ſide, e = leſſer, u = diagonal, and b = 880 yards = $\frac{1}{2}$ mile, in proceeding ſeveral ſteps you'll have $\sqrt{5} \times u = b - 2a$; put $g = \sqrt{5}$; then compleating

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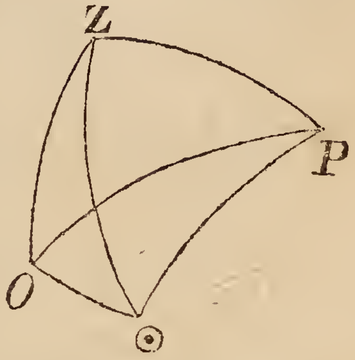
* V. QUESTION 115.

The time 8 h. $2\frac{1}{2}$ m. of ſun-ſet is found by adding $7\frac{1}{2}$ min. the half quarter to 7 h. 55 m. the time when the ſun is directly behind the top of the edifice; at which time let O denote the ſun's place, and ⊙ the point of ſun-ſet; alſo let Z be the zenith, and P the pole; and let the great circles be drawn as in the figure.



Then will ZPO be the hour angle of 7 h. 55 m. and ZP⊙ the hour angle of 8 h. $2\frac{1}{2}$ min. P⊙ or PO the given co-declination, PZ the co-altitude, ZO the co-altitude at the time of obſervation, and Z⊙ the co-altitude at the time of ſetting, which will be a quadrant, it being the diſtance between the zenith and horizon.

Wherefore, in the triangle ZP⊙ are given Z⊙, P⊙, and the ∠ ZP⊙; to find ZP the co-latitude. Then in the triangle ZPO, will be given ZP, PO, and their included ∠ ZPO; to find ZO the co-altitude at the time of obſervation. And, laſtly, the diſtance will be equal to the length of the ſhadow, which is the baſe of a right-angled plane triangle whoſe perpendicular is the height of the building, and the angle at the baſe the ſun's altitude; whence appears the reaſon of the laſt ſtating in the original ſolution.

pleating the ſquare $aa + ka + \frac{kk}{4} = \frac{bbg - bb}{14 - 4g} + \frac{bbgg - 2bbg + bb}{49 - 28g + 4gg} = \frac{45bbg - 10bbgg - 35bb}{880 - 588g + 168gg - 16g^3} = \frac{12098496{\cdot}879012673 +}{32{\cdot}30659103014048} = 374490{\cdot}04968136201.$

$a + \frac{k}{2}$ (i. e. $a + \frac{bg - b}{7 - 2g} = 430{\cdot}299969) = 611{\cdot}9559213549.$

Hence the greater ſide of the oblong is $a = 181{\cdot}65595$; e the leſſer $= 142{\cdot}80907$; diagonal $= 231{\cdot}06994$. Content 25942 ·1189 yards at 1*d.* ¼ comes to 135*l.* 2*s.* 3*d.* ½ 594.

The author of this queſtion, in the 4th line, by the words *the ſum of each ſide and end*, deſign'd to have meant one ſide and one end: Then the anſwer would have been 65097 ſquare yards, and purchaſe 339*l.* 11*d.* ¾; but the expreſſion will much eaſier mean both ſides and both ends, and the anſwer above truly ſolves the queſtion.* *The*

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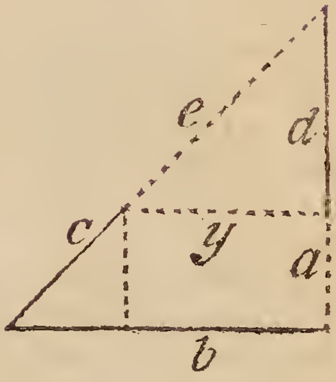
* VI. QUESTION 116.

As the queſtion is worded, the ſum of the four ſides and the diagonal muſt be equal to half a mile, and the diagonal a mean proportional between the end or breadth and ſum of the diagonal and the ſaid end or breadth.

Wherefore if $z =$ the diagonal, and $x =$ the breadth; then $xz + xx = zz$, and hence $x = z \times \frac{\sqrt{5} - 1}{2}$. Alſo, by right-angled triangles, the length $= \sqrt{zz - xx} = z\sqrt{1 - \overline{\frac{\sqrt{5}-1}{2}}|^2} = z\sqrt{\frac{\sqrt{5} - 1}{2}}$. So that the breadth, length, and diagonal, are to each other as $\frac{\sqrt{5} - 1}{2}$, $\sqrt{\frac{\sqrt{5} - 1}{2}}$, and 1; and therefore are in continual proportion.

Now the ſum of this diagonal with twice the length and breadth is $\sqrt{5} + \sqrt{2\sqrt{5} - 2}$; and then, by proportion, as this ſum is to half a mile (the ſum given in the queſtion), ſo is each of the above proportional quantities to the breadth, length, and diagonal of the figure required. Wherefore half a mile or 880 yards drawn into each of the fractions $\frac{\frac{\sqrt{5} - 1}{2}}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$, $\frac{\sqrt{\frac{\sqrt{5} - 1}{2}}}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$, and $\frac{1}{\sqrt{5} + \sqrt{2\sqrt{5} - 2}}$, will produce the required breadth, length, and diagonal.

The Prize Question answer'd by Mr. Sam. Marriot.



In this right-angled triangle wherein a line is drawn parallel to the base, there is given the base = 400; that segment of the hypothenuse next the base 200 = c; and the alternate segment of the cathetus 260 = d. To find the cathetus, &c.

$d + a : b :: d : \frac{db}{d+a} = y$,

$e + c : b :: e : \frac{be}{e+c} = y = \frac{bd}{d+a}$ per sim. triangles. Hence

$bde + bea = bdc + bed$, or $bdc = bea$, and $\frac{dc}{a} = e$. Again,

$bb + dd + 2da + aa = \frac{ccaa + 2dcca + ccdd}{aa}$ per 47 E. 1.

Hence $a^4 + 2da^3 \left.\begin{matrix} + bb \\ + dd \\ - cc \end{matrix}\right\} aa - 2ccda = ccdd.$

Then $a = 141\text{'}73$; $a + d = 401\text{'}73$ the distance sought; $c + e$ from first stat. to the camp 566'908; y = length of the ditch 258'883 yards.

Mr. R. Tapper *answers it thus:*

Let a = the distance of the wall from the ditch, $b = 260$ yards, $n = 200$, $m = 400$.

$\overline{1 + \frac{b}{a}} + \sqrt{nn - aa} = m$. which reduced will be

$a^4 + 2ba^3 \begin{matrix} + bb \\ + mm \\ - nn \end{matrix} aa - 2bnna = bbnn.$

Here a will be found 141'7005; $a + b$ = 401'7005 the distance of the camp of Marcellus from Syracuse.

The solution of this question may more fully be seen in Ward's Introduction, p. 334.

Of

Of the Eclipses in 1726.

Twice this year will the moon's dark body interpose between the sun and earth, and hide his face; and twice will the earth interpose, and hinder the sun from enlightning the moon: but only two of them will be visible in our part of the globe.

1. Sun eclipsed the 22d of March, about half an hour past 2 o'clock in the afternoon, invisible, by reason of the moon's south latitude, but will be pretty large, and seen about the Straights of Magellan.

2. Moon eclipsed the 5th of April, at 2 in the afternoon, invisible, she being then below our horizon; but in the eastern parts of Tartaria, Mogol, China, &c. it will be above 8 digits eclipsed on the northern limb.

3. Sun eclipsed the 14th of September, a quarter past 5 in the afternoon, visible.*

		Begin.	Midd.	End	Dur.	Dig.
		h. m.	h. m.	h. m.	h. m.	
Astronom. Car. at	Coventry	IV 25	V 17	VI 7	I 42	5 46
Mr. Chattock,	Coventry	4 26	5 17	6 17	1 50	6 44
Mr. Chattock,	London	4 28	5 25	6 18	1 49	6 46
Mr. Leadbetter,	London	4 44	5 37	6 27	1 43	6 3
Mr. Sparrow,	Nottingham	4 23	5 12	6 6	1 44	6 1
Mr. Child,	Newport	4 44	5 37	6 27	1 43	6 4
Mr. Turner,	Hull	4 20	5 14	6 2	1 42	5 29

4. Moon

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* This eclipse was observed

1. At *Lisbon* by F. *J. Bapt. Carbone.*

	True time. h.	m.	s.
Beginning — — — —	3	59	50
Middle — — — —	4	58	30
End — — — — —	5	56	50

The digits eclipsed were $7\frac{3}{4}$.

2. At *Ingolstat* by the *Fathers* of the *Society* of *Jesus.*

The beginning at 5 h. 17 m. 52 s.
The sun's semi-diameter measured exactly 16′ 00″.

4. Moon eclipſed on Friday the 30th of September, at 5 o'clock in the morning, viſible.*

		Begin.		Midd.		End		Digits	
Aſtronom. Car. at	Coventry	III	55	V	4	VI	13	4	45
Mr. Chattock,	London	3	26	4	50	6	14	6	36
Mr. Leadbetter,	London	3	53	5	3	6	14	4	58
Mr. Turner,	Hull	3	34	4	49	6	4	5	28
Mr. Sparrow,	Nottingham	2	30	4	55	6	0	5	27

A Letter

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* This eclipſe was obſerved

1. At *Liſbon* by F. *J. Bapt. Carbone.*

	True time correct. h.	m.	s.
Beginning of the penumbra —	14	37	00
Beginning of the eclipſe — —	14	57	20
End of the eclipſe — — —	17	33	30
End of the ſenſible penumbra —	17	54	00

The quantity eclipſed $6\frac{1}{6}$ digits.

2. At *Pekin* by F. *Ignat. Kegler.*

	Correct time. h.	m.	s.
Beginnning — — — —	12	49	0
Total Immerſion — — —	14	46	30
Emerſion — — — —	15	27	30
The end — — — —	16	26	0

The apparent diameter of the moon 32′ 30″.

3. At *Padua* by S. *J. Poleni.*

	App time. h.	m.	s.
Senſible penumbra — —	16	16	44
Beginning of the eclipſe ——	16	21	19

Clouds prevented the obſervation of the end.

A Letter to the Author.

——'Tis natural to moſt part of mankind to deſpiſe what they don't underſtand, and to paſs their judgments from appearances: And ſince your diary is but ſmall, and call'd an almanac, they who are ignorant of the mathematics, are apt to think meanly of that part of it, and conclude your correſpondents very fond of having their names in print, if not charge them with enormous pride and downright folly, in having their names put to the queſtions they propoſe to anſwer. I therefore being a party concern'd, could wiſh that ſome of your correſpondents would vindicate us from ſuch imputations, and ſet the diary and our performances in a true light. And ſuch perſons ought to be told, Firſt, of the extenſive uſes of mathematical learning, and of the infinite advantages they are to mankind; that the ſtudy is not only delightful, but quickens the invention, ſtrengthens the judgment, and enlarges the intellectual faculties. Secondly, that in the diary there has been exhibited a great number of difficult, curious, and uſeful queſtions, in all branches of the mathematics, not to be found in any author, with the beſt methods of ſolving them, which in any other method probably would never appear to the world. Thirdly, That the diary has incited and led many perſons to the ſtudy of mathematics, who otherwiſe perhaps would not have turned their thoughts that way, and has alſo exerciſed thoſe who have before ſtudied them ſo as not to forget what they learnt, and by exciting an emulation whereby they extend their mathematical knowledge. Fourthly, That your correſpondents who anſwer all or moſt of the queſtions, muſt well underſtand almoſt all parts of the mathematics, which doubtleſs is praiſe enough! That thoſe who anſwer only ſome few of the queſtions muſt underſtand arithmetic very well, if they are not acquainted with geometry. So that the leaſt knowing of the anſwerers are capable of any buſineſs wherein the knowledge of arithmetic and ſome part of geometry are requiſite. The ſolving of ſome queſtions does take up much time, and exerciſes as well the practic as theoretic part of the mathematics. And ſurely to employ one's leiſure hours pleaſantly, innocently, and profitably, with inconſiderable charge, is highly commendable; eſpecially ſince time is generally fooliſhly and expenſively thrown away, &c.

Yours, *Richard Whitehead.*

New

New Questions.

I. *Question* 117, *by Mr.* Richard Whitehead.

Having lately the great ſatisfaction to meet
With ſome quaint virtuoſos, at an elegant treat;
In a bowl of good nectar we drown'd ev'ry care,
And our chat and our liquor did equally ſhare:
How ſweet paſs'd our time, as we ſat round the table,
Meaſur'd out by the true horological ladle.
The bowl of flint-glaſs, of particular form,
Where this minute hand did with ſuch ev'neſs turn,
As when full, of our mirth it had been the gay ſource,
Gave, when empty, the riſe to a learned diſcourſe;
(For emptineſs oft, by the bye, has been found
To occaſion deep talk, and diſcourſes profound)
To be ſhort, in the firſt place they all did agree,
An hyperbolic conoid its inſide to be,
Whoſe abſciſſa was inches and parts as you ſee, 5·98
The line next, the inches and decimals ſhews,
Which its tranſverſe diameter went to compoſe. 6·93
The bowl's leaſt diameter they all did opine
Five inches to meaſure, and parts twenty-nine: 5·29
And they took, pray obſerve it, its ſides which went ſtraight
To be part of the aſymptotes; and to give us more light,
Of either of theſe ſee the length * ſhewn below.
This, they ſaid, was all that a perſon need know,
Its inner diameter right to unfold,
How much it might weigh, and what punch it might hold.
I allow'd what they ſaid, and I told them, with eaſe,
I cou'd ſend them an anſwer to queries like theſe,
So ſanguine I was; yet on ſetting about it,
After all my great workings, I found myſelf routed.
So ladies I hope, ſince I'm put to a ſhift,
You'll give your moſt humble admirer a lift.

* $8\frac{727609}{936000}$

II. *Question* 118, *by Mr.* Chriſt. Maſon.

Propitious ladies, who are ſkill'd in arts,
Divide ten thouſand into two ſuch parts,
When each of them the other has divided,
Both quotients make juſt five (if right decided).

III. *Queſtion* 119, *by Mr.* John Turner.

As I was walking out one ſummer's day,
To ſee the verdant fields and meadows gay,
By chance I did a geodeſian ſpy,
Who was ſurveying then a cloſe, hard by,
Of oval form; but ſuch an odd way he went,
By which to find its area or content,
As I before that time, nor ſince, e'er ſaw.
From one o'th' foci to the curve he drew *feet*
Three lines, whoſe lengths the page doth ſhew: 200
The angle between the firſt and ſecond, 313·62
Twenty-five degrees exact was reckon'd; 872·62
Between the ſecond and third he knew,
'Twas threeſcore and five preciſely true.
From hence the area you may quickly find:
And one thing more let's know, pray be ſo kind;
Quite croſs the ſaid ellipſe a ditch is made,
Which cuts the tranſverſe axis, (as he ſaid)
Two hundred feet from center, as you may
Suppoſe, in manner it inclining lay:
The leſſer ſegment of the ditch I know,
Is of all lines the ſhorteſt you can draw
From that point i'th' axis to periph'ry;
What length's each part, ladies, let us ſee.

IV. *Queſtion* 120, *by Mr.* John Simmons.

An oval marble fountain's to be made,
'Midſt of a fine partarre, give's your aid,
To tell the true dimenſions, from the ſhade
Of the forced water, thro' a jet d'eau;
Which ten foot at right angles it muſt throw
Above the fountain's brim——obſerve, the ſixth o' June
The ſhade o' th' top, by the meridian ſun,
Gives half the conjugate;——likewiſe, at two
Hours and five minutes after, come and view
Where the ſhade muſt croſs the fount's periphery,
Ten inches ſhort of the ſhade's length you'll ſee
A point, which there does bound the curvity.
The garden's latitude is known to be 52° 56′
But if that day the ſun ſhou'd not ſhine clear,
Exert your ſkill, and theſe four things declare:
Tranſverſe, conjugate, and the depth pray tell,
When ſixty wine hogſheads can the fountain fill.
This lin'd with lead all o'er, thus * thick, the weight
In pounds avoirdupois, inform me right.

* $\frac{3}{5}$ of $\frac{4}{9}$ of an inch.

V. *Queſ-*

V. *Question* 121, *by Mr.* Tho. Grant.

Not far from Cairo, in the Egyptian land,
Amongſt their ancient monuments does ſtand
A ſmall round temple, whoſe circumference
Is juſt one hundred yards and ſeven-tenths.
Its convex front is artfully adorn'd
With hyeroglyphics exquiſitely form'd.
A ſpiral tube encircles it around,
Making an angle with the level ground,
Of ſixty-one degrees and minutes five,
Till at the temple's top it doth arrive.
From whence, thro' this ſaid tube an iron ball
By its own gravity let freely fall,
Will to the bottom run in ſeconds eight:
From hence, I pray, declare the temple's height.

VI. *Question* 122, *by Mr.* Sam. Marriot.

A grandſire to his four grandchildren ſaid,
I have a piece of land was once ſurvey'd;
An oblong form i'th' midſt o'th' marſh doth lie,
This formerly was fenc'd about; but I
(Being weary of the charges) threw it ope,
And eat it main with all my neigb'ring folk,
Left nothing ſtanding but a thriving oak
At the eaſt corner; leſt I ſhould be fain
In time to come, to fence it out again.
The length, the breadth, the content too of it
Were fooliſhly upon looſe paper writ:
Yet I the ſame laid by (I thought) with care;
But now I want it, 'tis I know not where.
But this may uſeful be: I did reſolve
Diag'nal wiſe to hedge this cloſe in half:
A line let fall from th' corner of the cloſe
To the diagonal right angles ſhows,
Which cut a ſegment juſt of chains ſixteen
From the diagonal; and if't had been
Prolong'd two chains, would touch the other ſide;
Theſe two croſs lines would this oblong divide
Into four parts, ſuch as I give to you
reſpectively; and this is all I know.
Now, fair ones, leſt they the land ſhould loſe,
Pray in your next theſe four ſhares expoſe.

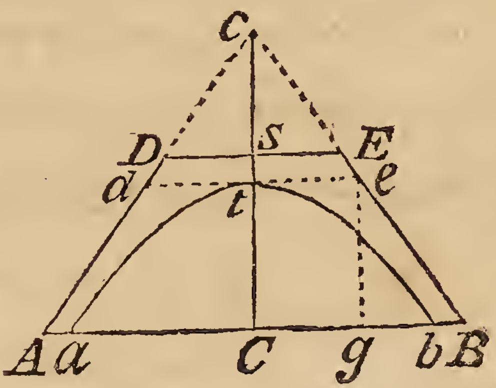
The Prize Question.

Fam'd Eboracum, once Brigantium's height,
Renowned was by many a worthy wight.
Four emperors did there receive their birth,
And three inhum'd, ſleep in that hallow'd earth.
Severus and Conſtantius there repoſe,
And Chlorus too, in peace with all their foes.
The fourth moſt fam'd, was the great Conſtantine,
Whoſe name thro' all the chriſtian world did ſhine;
Was the firſt emperor that wou'd embrace
The chriſtian faith, and baptiz'd at that place.
What ſtill adds luſter to renowned York,
A fabric ſtands of ſtately gothic work;
Whoſe lofty tow'rs o'erlook the ſpacious plain,
And view'd with wonder o'er a vaſt champaign.
The weary trav'ler ſees the diſtant place,
Believes him there, amends his ſlack'ned pace;
Pleas'd the refreſhing proſpect to ſurvey,
Each ſtride he lengthens to beguile the way.
For high in air the lofty turrets riſe,
Peep o'er the diſtant plains before the dazzled eyes.
As once I travell'd t'ward that ancient place,
I pry'd to ſee't, tho' diſtant many a pace;
By optic tubes, to help th' defective eye,
With th' horizon, St. Peter's I did ſpy:
When twenty miles I nearer was, did ſee
The apex then exalted one degree.
My eye was juſt five feet ſix inches high.
By what is ſhewn, the height I pray deſcry?

1727.

Queſtions anſwer'd.

I. *Queſtion* 117 *anſwer'd by Mr.* Chriſt. Maſon.



$cC = b = 9{\cdot}445$
$Ds = c = 2{\cdot}645$
$AD = d = 8{\cdot}777$
$cs = a = ?$
$b - a = Cs$

$$a : c :: b : \frac{bc}{a} = CB$$

$$b - a : a :: d : \frac{da}{b-a} = Dc$$

$$a : \frac{da}{b-a} :: b : \frac{bd}{b-a} = Ac$$

$$\frac{bbcc}{aa} = CBq$$

$$\frac{bbdd}{bb - 2ba + aa} = Acq$$

$$\frac{bbdd}{bb - 2ba + aa} - bb = CBq = \frac{bbcc}{aa}.$$

Which equation reduced, &c. gives $a = 2{\cdot}93$, from which all the other dimenſions may be eaſily found. Then *per Archim. de Conoid & Spheroid, Def.* 3, the truncated cone *AdeBbta* will be = a cylinder generated by the parallelogram *Cteg*. Ergo, from the fruſtum *AdeBA*, take that cylinder, the remainder will be = the ſolidity of the hyperbolic conoid *atba*; to which cylinder add the fruſtum *dDEed*, the ſum will be equal the ſolidity of the bowl = 197·873 inches. The ſolidity of the conoid = 499·774 inches = 2·1635 wine gallons.

Then by {Phil. Tranſ. / Ward,} an inch of glaſs weighs {1·54282 / 1·493037} ounces avoird.

And the weight of the bowl {(1) 305 oz. = 19 lb. 1 oz. / (2) $294\frac{1}{4}$ oz. = 18 lb. 7 oz.} avoirdupois.

II. *Queſ-*

* II. *Question* 118 *answer'd by Mr.* R. Whitehead.

The two numbers $\left\{\begin{matrix}1726{\cdot}73164\\8273{\cdot}26835\end{matrix}\right\}$ added make 4·99999 &c.

† III. *Question* 119 *answer'd by Mr.* W. Gill.

Dr. Keil, in his Astro. Lect. gives a method of determining an ellipse from 3 lines given in length and position, cutting each other in the focus. The

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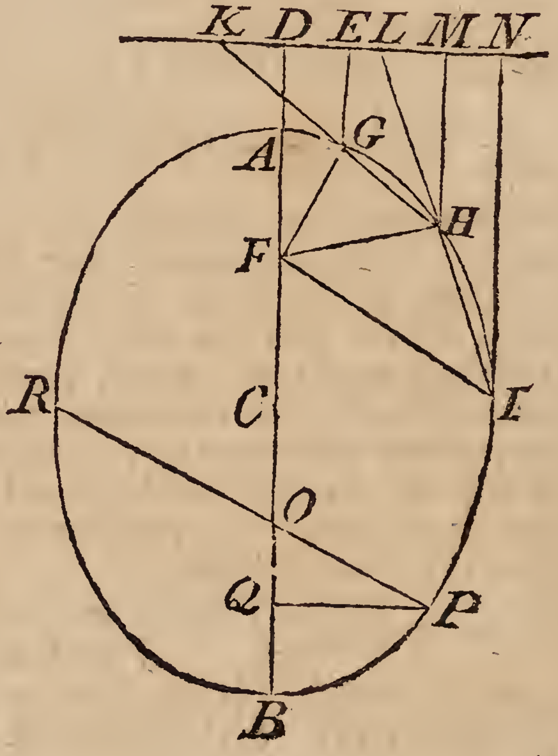
* II. QUESTION 118.

Let x and y denote the two numbers, s their sum, and q the sum of their alternate quotients.——Then $x+y=s$, and $\frac{x}{y}+\frac{y}{x}=q$: Hence $xx+yy=qxy$, and $xx+2xy+yy=ss$; or, by substitution, $qxy+2xy=ss$; therefore $4xy=\frac{4ss}{q+2}$; and, by subtraction, $xx-2xy+yy=ss-\frac{4ss}{q+2}=\frac{q-2}{q+2}\times ss$; therefore $x-y=s\sqrt{\frac{q-2}{q+2}}$.

$$\text{Consequently}\left\{\begin{aligned}x&=\tfrac{1}{2}s+\tfrac{1}{2}s\sqrt{\frac{q-2}{q+2}},\\ y&=\tfrac{1}{2}s-\tfrac{1}{2}s\sqrt{\frac{q-2}{q+2}}.\end{aligned}\right.$$

† III. QUESTION 119.

It is demonstrated, by the writers on conics, that if C be the center and F the focus of an ellipse, and in the transverse axe BA produced there be taken CD a third proportional to CF and CA, and from any point G in the curve GE be drawn parallel to BD and meeting DE parpendicular to it in E, and FG be drawn; then FG will always be to GE, in the constant ratio of CF to CA.——Wherefore, if G, H, I be the three given points, or ends of the given lines FG, FH, FI, drawn from the focus F; and there be drawn HG, IH, and produced to K and L so that HK be to GK as FH to FG, and IL to HL as FI



to

The tranſverſe diameter 1000 feet, conjugate 600, the content of the field 10 a. 3 r. 10 perches, the angle of inclination of the tranſverſe 64° 21′. From the doctrine of fluxions, if the leſſer ſegment be ſuppos'd to be the hypothenuſe of a right-angled triangle, alſo a minimum, and a perpendicular let fall upon the tranſverſe diameter. The baſe of the ſaid triangle will be a fourth proportional to the tranſverſe, the latus rectum, and the diſtance of the perpendicular from the center of the ellipſis, that is $1000 : 360 :: 200 + x : x = 112.5$. Hence the leſſer part of the ditch $= 259.8$, greater $= 330.66$, and the whole length $= 590.46$.

IV. *Queſ-*

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to FH; and then if KL be drawn, and perpendicular to it IN, HM, GE, FD; and laſtly FD be divided in A in the given ratio of FG to GE; then A will be the end of the tranſverſe, and the whole of the ellipſe is thence determined.——For, KH being to KG as FH to FG by the conſtruction, and KH to KG as MH to EG by ſimilar triangles, therefore FH will be to FG as MH to EG, or FH to HM as FG to GE; and in the ſame manner $FI : IN :: FH : HM$; wherefore in general $FI : IN :: FH : HM :: FG : GE ::$ (by the above cited property) $CF : CA$; whence the center C and the whole ellipſe becomes known.

Again, for the ſhorteſt line OP that can be drawn from the given point O in the axe to the curve; ſince it muſt evidently be perpendicular to the curve or to the tangent in the point P, it may be determined from that conſideration alone and the property of the curve, independent of fluxions; and from thence will eaſily ariſe the property of it mentioned in the original ſolution, and as is actually determined at *prop.* 10 *lib.* 5 *Apol. Con.* viz. AB : latus rect. : $CQ : OQ$; hence the point Q is found, and of conſequence OQ; and then OR as in queſtion 103 page 246.

* IV. *Question* 120 *answer'd by Mr.* Mason.

Given the lat. —	52°	56′
Its complement —	37	4
Sun's declination add	23	25
Sun's merid. altitude	60	29
As s. sun's altitude	60	29
To the height obj. —	120 in.	
So is cos. sun's alt.	29°	31′
To length shadow —	67·989	
As radius		
To cos. time from noon	58°	45′
So is cos. lat. — —	52	56
To tang. of a 4th arch	32	51
Which sub. fr. ☉'s dist. of pole leaves a 5th arc =	33°	44′
Cosine 4th arch —	57	09
To cosine 5th arch —	56	16
So sine of the lat. —	52	56
To sine of the altitude	52	11

As sine of the altitude	52°	11′
Is to the height 120 inches		
So cosine altitude —	37°	49′
To length of shadow 93·155 in.		
From which subtract 10 inch.		
Remainder 83·155.		
As cosine sun's altitude	37°	49′
To sine time past noon	31	15
So cosine ☉'s declin.	66	34
To sine sun's azimuth	50	55
As radius — —	90	0
Is to — — —	83·155	
So cosine azimuth —	50°	55′
To the ordinate *ea* =	52·4	
As radius		
To — — —	83·155	
So sine — —	50°	55′
To *de* — —	64·53	

Let.

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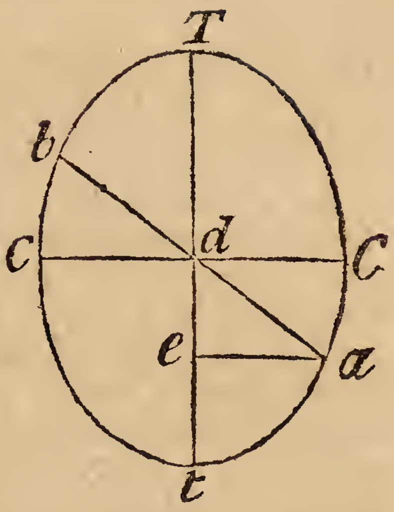
* IV. QUESTION 120.

The spherical calculations, in the original solution above, will be evident by applying the given declination, latitude, and hour to the spheric triangle in page 227; for if ZP represent the co-latitude, $P\odot$ the co-declination, and their included angle P the hour from noon, all which are given; then $Z\odot$ will be the co-altitude, and the $\angle Z$ the azimuth, both which are hence easily found.

Again, for the ellipse, instead of the jet d'eau suppose a pole of 10 feet high erected in the center d of the ellipse; then will the shadow of it at noon be the semi-conjugate axe dc, and 10 inches less than the shadow of it when the azimuth is equal to the $\angle adC$ will be the semi-diameter $db = da$. Which are easily determined as in the original solution.

Every thing else in the original solution is very well determined, except the transverse axe, which may be better found thus, by the common property of the ellipse, as $\sqrt{dC^2 - ae^2} : dc :: dC : dT$ the semi-transverse.



Let $ea = b = 52 \cdot 4$
$dC = c = 67 \cdot 989$
$de = d = 64 \cdot 53$
And $et = a$. *Quære* a?
$dd + 2da + aa : cc :: da$
$: \dfrac{ccda}{dd + 2da + aa} = bb.$

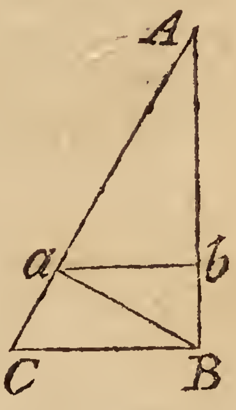
Reduced, $bbaa + 2bbda - ccda = bbdd$. In numbers produces $a = 36 \cdot 86$. Then $1 : \cdot 7854 :: Tt \times cC : 21640 \cdot 4668$ inches = the area, by which divide the given content, gives the depth $40 \cdot 35$ inches. Add twice the thicknefs of the lead to each diameter, and once to the depth: from which elliptical cylinder fubtract the given content, gives the inches of lead 11614, which according to Ward's fpecific gravity of lead, is equal to 76116 ounces avoirdupois = 2 tun, 2 hund. 1 quar. $25\frac{1}{4}$ lb. weight.*

* V. *Queftion* 121 *anfwer'd by Mr.* Whitehead.

The propofer has either unlimited or unhing'd the queftion, by giving the circumference of the tower incoherent with the time; either alone would have limited it.

According to Gallilæus, and experiments made by feveral ingenious artifts of late, as

$1 : 16\frac{1}{12} :: 8'' \times 8'' = 64 : 1029\frac{1}{3}$ = the fpace a body will defcribe a perpendicular defcent in 8″ of time. Then



As the fine of given angle $ACB = 61^\circ 5'$
Is to the fide — — $AB = 1029\frac{1}{3}$
So is the radius
To the hypothenufe $AC = 1175 \cdot 81$

Then let fall the perpendicular aB, and while a body accelerates the fpace AB, another will defcribe the fpace Aa, along the inclin'd plain AC, as has been demonftrated by the illuftrious Sir Ifaac Newton. Having found the fegment $Aa = \dfrac{AB^2}{AC} = 901$, &c.

Say, as radius : $Aa = 901$, the length of the tube :: s. of the given angle $Aab = 61^\circ 5' : Ab = 788 \cdot 72$ feet, the height required.

Mr.

Mr. Grant's *solution to the 121st question, taken from the Diary for* 1729, *and who thinks Mr.* Whitehead's *solution was not right.*

As 1 : 193 : 64 :: 12352 inches = the perpendicular descent of the body by gravity in 8″ of time: Then as the radius : sine of 61° 5′ :: 12352 : 10812 inches = the space described in 8″ by a body descending along a plain that makes an angle of 61° 5′ with the horizon, which would be the tube's length were it a right line, but being a spiral to the temple which the question supposes a cylinder whose periphery is 100·7 yards; it is evident, that as the ball descends it will also by the tube's curvature be carried in the said periphery, therefore it will be acted on by a *vis centralis*, in a direction parallel to the horizon, which will not forward the ball's descent, but will constantly diminish it, and consequently the velocity that would arise therefrom, which will occasion the ratio of the spaces described by the ball descending in the tube, to the times of their description to be always variable. Wherefore I compare in a ratio, as the semi-ordinate of a conic parabola to their respective abscissas, whence the following analysis: where x = tube's length the ball runs in 8″.

Radius : cos. 61° 5′ :: x : ·483537x = to an arch described in 8″, in the periphery, which squar'd, divided by the diameter, gives ·0002026167xx = the space in 8″, agitated only by the central force; which multiply by x^2, and make it the abscissa of a parabola convex to its axis, x its ordinate, and the parameter will come out = 4935·427 in. = a, the parabol. curve, by compounding the motions along the ordinate and abscissa, will be = 10812 inches = the space in 8″, by a body descending along the inclin'd plain. Then, by the doctrine of fluxions, x = 6175 inches = $514\frac{7}{12}$ feet the tube's length, and radius : s. 61° 5′ :: 6175 : 5405 inches = 450 feet, the temple's height.*

VI. *Ques-*

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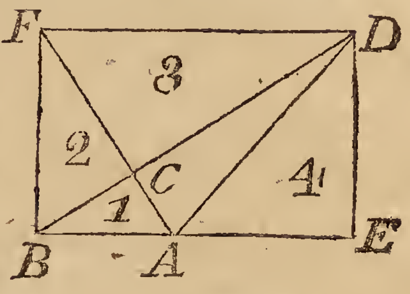
† V. QUESTION 121.

After all Mr. Grant's labour and time spent in the solution of this question, Mr. Whitehead's solution is right. For the side of the tube, by impelling the ball in the horizontal direction, does not alter its perpendicular velocity or descent; and therefore the spiral may be considered as a streight inclined plane in the solution.

VI. *Question* 122 *answer'd by Mr.* Sam. Rouse.

Draw DA. Then $\triangle DAB = \triangle FAB$ by Eucl. I. 37, $\because \triangle DAC = \triangle FBC$.



Put $AC = b = 2$, $CF = a$, $CD = 16 = d$, $CB = e$.

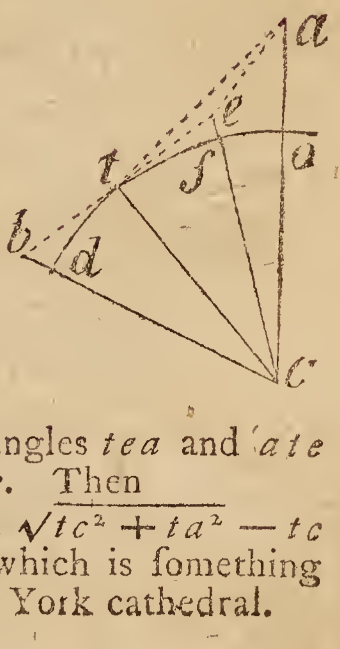
E. VI. 8.	1	$b : e :: e : a$
$\because$	2	$ba = ee$
But	3	$ae = bd$
$3 \div e$	4	$a = \frac{bd}{e}$
$2 \div b$	5	$a = \frac{ee}{b}$
4 and 5	6	$\frac{bd}{e} = \frac{ee}{b}$
$6 \times$	7	$dbb = eee$
$7 w 3$	8	$\sqrt[3]{bbd} = e = 4$ chains.
E. 8. 6.	9	$AC : CB :: CB : CF = 8$ ch.

	A.	R.	P.	
(1) $BCA =$	0	1	24	shar.
(2) $BFC =$	1	2	16	
(3) $CFD =$	6	1	24	
(4) $ACDE =$	7	2	16	
Total	16	0	0	

This question is in page 367 Hill's Arithmetic.

The Prize Question answer'd.

Let	1	$r =$ radius of the earth $= tc$,
	2	$h = bd$ or $ef =$ height of eye;
36 E. 3.	3	$2rh + hh = bt^2$
$3 w 2$	4	$\sqrt{2rh + hh} = bt$
Then	5	$bf - bt = tf$,
And	6	$\angle cea = 91°$ per quest.



Then find the angle tce, and line te; find the angles tec and etc; subtract the angle etc from 90°, it leaves the angle eta. Again, to the angle tec add $\angle cea$, which sum subtract from 360, leaves the angle tea. Then the angles tea and ate subtracted from 180, leaves the angle tae. Then

As sine $tae : tc ::$ sine $tea : ta$. And $\sqrt{tc^2 + ta^2} - tc = ao = 260\frac{3}{4}$ feet, the height sought; which is something more than the real height of the tower of York cathedral.

Of the Eclipses in 1727.

Twice this year will the moon's dark body interpose between the sun and our part of the earth, and hide part of his face from our light. But only one will be visible.

1. Sun eclipsed, on Saturday the 11th day of March, at 8 at night, but not visible to us by reason the sun is then set.*

2. Sun eclipsed, on Monday the 4th of Seprember, at 7 in the morning, about 2 digits, invisible. The calculation by Street's Caroline Tables, for the meridian of the city of Coventry.†

The beginning at Coventry — —		VI	31
The middle or greatest observation		VII	3
The end — — — —		VII	35
The whole duration — — —		I	5
Digits eclipsed south — —	1	56	58

New

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* This eclipse was observed

At *Vera Cruz* by Mr. *J. Harris*.

	App. time h.	m.
The beginning — — — —	0	$49\frac{1}{2}$
Middle as near as could be judged — —	2	30
End about the N. N. E. part of his disk —	3	$59\frac{1}{2}$

† This eclipse was observed thus:

At	By	Beginning h.	m.	s.	End Ant. Merid. h.	m.	s.
Lisbon	F. J. Carbone	—	—	—	7	9	2 true time
Padua	J. Polenus	—	—	—	8	38	42 true time
Rome	J. D. Maraldi	—	—	—	8	44	10 true time
Bologna	E. Manfredi	—	—	—	8	36	6
Wirtemberg	J. F. Weidlerus	7	18	19	8	29	51

New Questions.

I. *Question* 123, *by Mr.* Rich. Whitehead.

As a Philomath Cato, with attention profound,
Was preparing a map of ſome neighbouring ground;
And to objects remote was directing his eye,
With his body half bent, 'twas my chance to come by:
We fell into talk (for you muſt know for ſome years
I've been a ſmall trader in angles and ſquares);
He told me what methods he took, and what ways,
To determine the diſtance of this from that place.
Says I, you go wrong, friend, or at leaſt round about,
To arrive at this thing, there's a much nearer route.
On this, Euclid's ſon, with a ſneer, made a motion,
That I'd practiſe what he thought was only a notion.
What I ſaid I cou'd no ways refuſe to make good,
And the caſe that he choſe for my trial thus ſtood:
Three towns there were lying (to prevent any blunder,
Call *B*, *C*, and *D*) many paces aſunder;
The diſtance of each one of theſe from a town
That was placed within them, call'd *L*, was well known,
It being in miles and in yards as below is ſhown.
From the towers of the two firſt-named places I took
The angles from one to another; pray look
At the bottom*, for there their true meaſures appear:
But from none of thoſe tow'rs, if I look'd a whole year,
Cou'd I've ſeen the town *L*, it was plac'd down ſo low;
For want of which height I was forc'd to let go
My deſign, which I boaſted I'd ſoon bring to paſs,
And deſiſt from my work with no very good grace.
So, ladies, I hope, for this once, you'll deſcend,
To aſſiſt a poor well-wiſhing batchelor friend:
For the future, no more ſuch vain toils I'll purſue,
And leave off ſurveying——unleſs 'tis of you!

* The angle $B = 65^\circ\ 10'\cdot 96766$; $C = 77^\circ\ 0'\cdot 07237$; $D = 37^\circ\ 49'$.

$$\text{The lines } \left\{\begin{matrix} BL & 7 \\ CL & 6 \\ DL & 4 \end{matrix}\right\} \text{ miles } \left\{\begin{matrix} 528 \\ 880 \\ 704 \end{matrix}\right\} \text{ yards.}$$

II. *Question* 124, *by* Philosophicus.

Strephon unfortunate! by cruel fate,
He's quite bereav'd of his most happy state.
Celia, whom he dearly did adore,
Bright object of his amorous desire,
She's lost, unheard of by some ill adventure.
He's oppress'd with utmost grief for his great loss,
In sighs and tears he wails his wretched case:
No pains he spares, the fair to have again,
But O, she's gone! his search proves all in vain:
Yet, fill'd with fierce desires, he will pursue
A search incessant, still her fate to know.
Ev'n thro' all parts o'th' spacious world he'll rove,
Nothing shall him deter, so inspir'd by love.
After a long and tedious course of travel,
Having lasted all its great fatigue and toil,
He to a distant country then is thrown,
A place fam'd for an oracle divine.
Now, cries the joyful youth, my hopes revive!
This sage diviner may some tidings give.
Then straight he hasten'd to the sacred place,
Where stood the oracle, and there his case
Before him laid; then earnest did invoke
His pow'r: when thus the sacred statue spoke:
This place is in the latitude of forty-eight,
If hence on this meridian thou mov'st streight
With equal motion, tow'rds the great equator,
And pass precise o'er fourteen miles each hour,
Accounting still the motion that was given
Thee, by the earth's diurnal revolution:
When by this compound motion thou hast gone
The space of fifteen hundred leagues and one,
There end thy journey; for thou would'st b' arriv'd
Unto the place where doth the fair reside.
Now, ladies, your bright wit must this explain;
And tell what latitude the nympth was in.

III. *Question* 125, *by Mr.* John Turner.

Within the northern artic circle stand
Three hills, which o'er the circumjacent land
Raise their aspiring top, in ice involv'd,
And snow by Phœbus' rays not yet dissolv'd,
A land-mark well unto the seamen known,
When driv'n by storms and tempests up and down,

I'th'

I'th' ſpacious depth; far diſtant they appear,
With heads invelop'd in the atmoſphere;
More fam'd than Teneriff, or Andes hill.
The height of *A*, for ſo the firſt I call,
In poles is thirty-two; the ſecond *L*,
Twice forty-eight, not more; the third, or *C*,
Its altitude exactly fifty-three.
And from the baſe of *A* to *L* is found,
Two hundred poles meaſur'd upon the ground.
Now't happens on a certain day i'th' year,
(But which I leave to you for to declare)
That th' utmoſt limits of the top of *A*
Its ſhade ſhall tranſit thro' the foot of *C*;
L's ſhade thro' *A* and *C* will take its way,
And that of *C* thro' *A* alternately.
From hence pray tell what's the ſun's declination,
And alſo what the pole's true elevation,
Where theſe phænomena will true appear,
And you'll oblige your humble ſerviteur.

IV. *Queſtion* 126, *by Mr.* Tho. Dod.

'Tis to you, lovely ladies, I ſue and ſubmit,
(Who out-vie Sidrophel in magic and wit)
For ſolution of this knotty problem propos'd,
By which undertaking my ſenſes are doz'd:
To find by what canon the ſquares you do fill
Which are magical call'd, and by that try your ſkill,
To place all theſe numbers * ſo that the amount
Juſt half a ſcore ways ſeventy-four you may count:
If you'll anſwer but this, now yourſelf do aſſure,
I will meddle with what they call magic no more.

* 8, 9, 10, 11, 14, 15, 16, 17, 20, 21, 22, 23, 26, 27, 28, 29.

V. *Queſtion* 127, *by Mr.* Tho. Williams.

Our modern nat'raliſts diſpute—Whence came
The water that deſtroy'd the earth's firſt frame?
Some bring it from the moon; and ſome have thought
That from above the firmament 'twas brought:
Others—that 'twas created for that end,
Or from a deep abyſs did then aſcend.
The laſt the ſacred writ doth intimate,
As Woodward has explain'd it to's of late:
The which abyſs (with Halley) he wou'd have
Concentric with the earth, an orb concave.

If ſo — an alternative change ſuppoſe;
Let air ſubſide, whilſt water earth o'erflows;
And while the earth's a ſea, let air in place
Of water fill up the orbicular ſpace.
For preſent uſe (with Burnet) we'll agree,
That the antidiluvian earth might be
Of mathematical rotundity;
And that th' abyſs did hold this weight * in air,
Which we'll admit no heavy'r there than here.
From hence, fair ladies, theſe two things unfold:
How deep the flood? how much th' abyſs might hold?

* 10000000000000000 tuns avoird.

VI. *Queſtion* 128, *by Mr.* Chriſt. Maſon.

The earth with Luna friſking round, do run
Their annual courſe about their lord the ſun;
And thro' th' ecliptic, as they ſteer their way,
Deſcribe the ſeaſons, meaſure night and day;
Yet hang on nothing in the limpid air;
And as they move, their maker's praiſe declare.
Beſides their motions, they do gravitate,
Which different actions equiponderate;
And tho' each ſphere a center has, yet they
One common center have, which may be call'd their way.
Where is that place, kind artiſts, ſhew it to me,
When thoſe two orbs at their mean diſtance be?

VII. *Queſtion* 129, *by Mr.* Sam. Rouſe.

Once I a noble ſtructure did behold,
Whoſe tow'ring walls, magnificent and rare,
Within were grac'd with curious effigies,
Drawn by ſweet touch of fam'd Angelo's art:
The top with glitt'ring ſtars was garniſh'd o'er,
In imitation of the ſpangled arch of
Heav'n's ſpacious canopy. In midſt
Of this rich place a golden candleſtick
Orbicular, adorn'd with branching flow'rs,
Suſpended, hung ſupported by a line
Fix'd to the roof. This candleſtick, one ſaid,
Oſcillates or vibrates in an hour's ſpace
A thouſand times: He likewiſe ſaid, this line
From top o'th' candleſtick, thence to the ground,
Was in extream and mean proportion known.
This ſtately fabric's height, fair nymphs, declare,
From marble floor up to the lofty roof.

The

The Prize Queſtion.

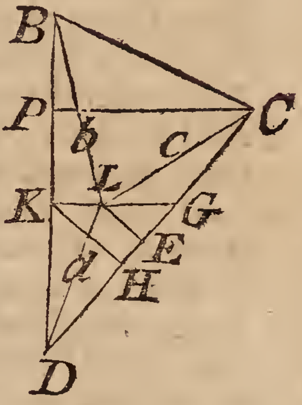
In fam'd Sicilia's iſle a garden lies,
From ſtorms defended, and inclement ſkies:
Fenc'd with a green incloſure all around,
Tall thriving trees confeſs the fertile ground.
A ſylvan ſcene in ſolemn ſtate diſplay'd,
Flutters each feather'd warbler with a ſhade:
The gentle ſpirit of the weſtern gale
Eternal breathes on fruits untaught to fail;
The ruling orbs no wint'ry horrors bring,
Fixed in th' indulgence of perpetual ſpring:
Here ſpices in parteres promiſcuous blow,
Not from Arabia's field more odours flow:
The order'd vines in equal ranks appear,
And verdant olives flouriſh round the year;
Here grapes diſdolour'd on the ſunny ſide,
And there in autumn's richeſt purple dy'd;
Beds of all various herbs, for ever green,
In beauteous order terminate the ſcene.
Sev'n chryſtal ſtreams, from ſev'n fair fountains flowing,
The lovely landſcape grace with ſoft murmurs,
In wild meanders ſlowly run, as ſeeming
Unwilling to forſake the pleaſing ſoil.
I'th' midſt of a graſs-plot, form'd with artful care,
Its radius fifty feet, being circular,
Two rectilinear walks from the center flow,
Making an angle as expreſs'd below: *55 deg.*
The length of *A*, from thence twice fifty-four,
Of *B* juſt eighty feet, nor leſs, nor more;
From whoſe extremities two lines muſt be
Drawn back to the circle's periphery,
Where (meeting) they muſt equal angles form,
On each ſide, with a tangent to be drawn
To the ſaid point of concourſe: Now what are
The lengths of theſe two lines, I pray declare?

Queſtions

1728.

Questions answer'd.

I. *Question* 123 *answer'd by the proposer's method.*



Put $a = BD$, $b = LB$, $d = DL$, $c = CL$, $m =$ sine $\angle CDB = 6131{\cdot}369$, $n =$ sine $\angle PCD = 7899{\cdot}767$, $r =$ radius $= 10000$, $s =$ sine $BCD = 9743{\cdot}748329$, $t =$ sine $\angle CBD = 9076{\cdot}46563$.

By trigonometry,

$\frac{ta}{s} = CD$, $\frac{mta}{rs} = CP$, and $\frac{nta}{rs} = PD$.

By oblique triangles,

$\frac{aa+dd-bb}{2a} = KD$, $\frac{ttaa+sscc-ssdd}{2sta} = CE$, and $\frac{ttaa+ssdd-sscc}{2sta} = ED$.

By similar triangles,

$$PD : PC :: KD : KG = \frac{maa+mdd-mbb}{2na},$$

$$PD : DC :: KD : DG = \frac{raa+rdd-rbb}{2na},$$

$$CD : CP :: GK : GH = \frac{mmaa+mmdd-mmbb}{2rna},$$

$$CD : DP :: KD : DH = \frac{naa+ndd-nbb}{2ra};$$

hence $GD - ED = GE =$

$$\frac{rstaa+rstdd-rstbb-nttaa-nssdd+nsscc}{2nsta},$$

Then by similar triangles,

$CP : PD :: GE : EL = rstaa +$ &c. divided by $2msta$,

or $EL = \frac{21538697327713058aa - 11{\cdot}839151262}{a} = \frac{qaa-p}{a}$;

also

alſo $CE = \frac{4657584190830917 33\,aa + 12{\cdot}28641236}{a} = \frac{kaa + l}{a}$

therefore $LE^2 + CE^2 = LC^2$;

that is, $\frac{qqa^4 - 2qpaa + pp + kka^4 + klaa + ll}{aa} = cc$,

or $2pqaa + ccaa - 2klaa - qqa^4 - kka^4 = ll + pp$;

that is, by diviſion and ſubſtitution, $xaa - a^4 = z$,

or $xe - ee = z$, by putting $e = aa$;

hence $e = aa = \frac{x}{2} + \sqrt{\frac{xx}{4} - z} = 127{\cdot}6958908986685$,

and $a = 11{\cdot}300260066 = BD$, and the reſt

$$\left.\begin{array}{l} CD = 10{\cdot}526383 \\ CB = 7{\cdot}1108241 \end{array}\right\} \text{miles} = \left\{\begin{array}{lll} 11\text{ m.} & 2\text{ f.} & 16\text{ p.} \\ 10 & 4 & 8 \\ 7 & 0 & 35 \end{array}\right.$$

Mr. *John Turner* has very curiouſly wrought this anſwer by trigonometry, and an algebraical proceſs to this biquadratic adfected equation,

$$\overline{1 + g^2}\,x^4 \begin{array}{c} -4cc \\ +2dxx \\ +2gh \end{array} = \begin{array}{l} -dd \\ -hh \end{array}$$

$x = \sqrt{ss - t} + s = 11{\cdot}2983$ miles, $10{\cdot}525$, and $7{\cdot}11$.

II. *Queſ-*

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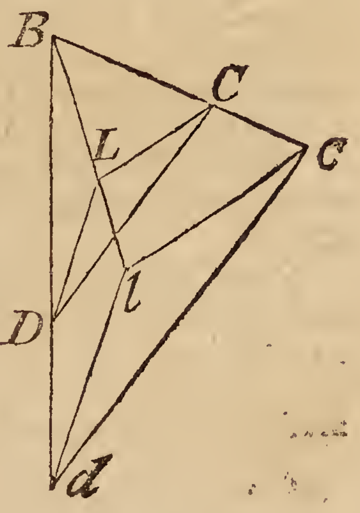
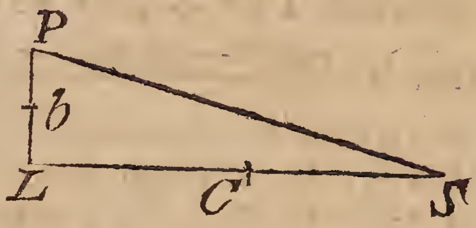
* I. QUESTION 123.



Deſcribe the triangle Bcd ſimilar to the propoſed one, or whoſe angles ſhall be equal to the given ones: then, by prob. 31 Simpſon's Geometry, determine the point l ſuch, that the three lines Bl, cl, dl may be in proportion to each other as the three given diſtances BL, CL, DL: upon Bl take BL = the given diſtance of B from L; and draw LD, LC parallel to ld, lc; and join D, C: ſo ſhall B, C, D, L be the four points required.

Which is too evident to need a formal demonſtration.

II. *Question* 124 *answer'd by Mr.* Turner



Let $SP = 4503$ miles $= d$, $b = 14$, and $c = 1039$ the number of miles which every point of the equator is carried through in the space of an hour, by the earth's diurnal revolution; then the ratio of PL to SL, will be ba to ca: But $b^2a^2 + c^2a^2 = dd$ Euc. 47. 1. Hence $a = \sqrt{\dfrac{dd}{cc + bb}}$, consequently $PL = ba = 60{\cdot}676$ miles, the difference of latitude, and the latitude arriv'd in will be $46^\circ\ 59'\ \frac{1}{4}$ north.

This may likewise be solv'd trigonometrically, and has some affinity to current sailing, the motion of the earth representing the current's motion, the man being carried by the compound motion from P to S: but each point of the parallel of 48° does not run through 1039 miles per hour, and the line PS will indeed be a spiral line upon the globe.

Mr. *Geo. Brown* has well answered and demonstrated this question, and found the latitude to be $46^\circ\ 16'$: but the operation and scheme my room will not admit.*

III. *Ques-*

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* II. QUESTION 124.

The original solution to this question is not right, because the motion in the parallel is made constantly equal to that at the equator; whereas the intent of the question seems to be, to find the spiral described on the globe by a point, which is urged with a given constant velocity in the direction of the meridian, and a given constant angular velocity around the pole in the direction perpendicular to the meridian; the rates being 14 miles on the meridian to the 24th part of the parallel of latitude.——Or it may be conceived by supposing a point to move along the brass meridian of a globe, at the rate of 14 miles while the globe turns round 15 degrees, the motion answering to an hour; for then the parts of the globe passing directly under the point, will trace out the spiral.

Wherefore, if x be put for the cosine of the variable latitude, and consequently $\sqrt{1 - xx}$ its sine to the radius 1; also $a = 14$ miles, and $b = 1$-15th part of the equator: since $bx =$ the motion per hour in the parallel of latitude, and $\dfrac{\dot{x}}{\sqrt{1 - xx}} =$ the

* III. *Queſtion* 125 *anſwer'd by Mr.* Brown.

There's a demonſtration of this in Sir Iſaac Newton's Univerſal Arithmetic, too large to inſert, by which I make the latitude 81° 30′, and ſun's declination 17° 22′.

Mr. *Maſon*, Mr. *Whitehead*, and ſome others ſay this queſtion is unlimited, or at leaſt admits of more true anſwers than one: but having received none but the above, I ſhall not here give my judgment till further trial be made at a more leiſure time, except Mr. *Bent*'s latitude 80° 45′, declination 19° 27′.

IV. *Queſ-*

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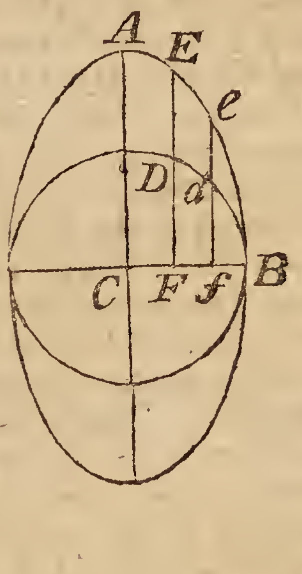
the fluxion of the arch of the meridian or abſciſſa of the ſpiral, we ſhall have as $\bar{a} : bx :: \frac{\dot{x}}{\sqrt{1 - xx}} : \frac{bx\dot{x}}{a\sqrt{1 - xx}} =$ the fluxion of the parallel or ordinate of the ſpiral; then the ſum of the ſquares of theſe fluxions of the ordinate and abſciſſa will be equal to the ſquare of the fluxion of the curve of the ſpiral, or fluxion of the ſpiral $\dot{z} = \dot{x}\sqrt{\frac{aa + bbxx}{aa - aaxx}}$, or $= \dot{x}\sqrt{\frac{1 + qxx}{1 - xx}}$ by putting q for $\frac{bb}{aa}$. Now, by Cor. 2 pa. 228 Menſuration, it will be found that this expreſſion is the fluxion of an elliptic arc whoſe ſemi-axes are 1 and $\sqrt{\frac{aa + bb}{aa}}$. Wherefore if the circle whoſe radius is 1 be circumſcribed by the ellipſe whoſe tranſverſe ſemi-axe AC is $= \sqrt{\frac{aa + bb}{aa}}$, and BD be the degrees or arc of the latitude, and EDF be drawn parallel to AC; then CF will be $= x$, and the arc $AE = z$ the above fluent, or length of the ſpiral from the pole: Alſo Ee will be the length of the ſpiral between any two latitudes BD, Bd. So that if BD be the given latitude of 48°, and DE be drawn parallel to AC; then take $Ee = 4503$ miles the propoſed length of the ſpiral, and draw ed parallel to ED; ſo ſhall Bd be the latitude required.



* III. QUESTION 125.

This queſtion has evidently been made from prob. 55 of Sir Iſaac Newton's Arithmetic, where a full ſolution may be ſeen.

IV. *Question* 126 *answer'd.*

Mr. *Elias Colbourn* ſays, if the numbers as given be placed in four rows, you need only let the diagonals ſtand, and croſs places with the other numbers as in theſe ſquares.

8	9	10	11
14	15	16	17
20	21	22	23
26	27	28	29

The numbers plac'd as given in the queſtion.

8	28	27	11
23	15	16	20
17	21	22	14
26	10	9	29

Tranſpos'd, which makes 74 ten ways, viz. laterally, tranſverſly, and diagonally.

Aſpatia ſays, the method of filling all ſorts of magical ſquares with the magic cubes, may be ſeen at large in the memoirs of the royal academy of ſciences for 1710, page 124, by Monſ. Saurier, in his Conſtruction Generale des Quarrés Magiques.

V. *Question* 127 *anſwer'd by Mr.* Whitehead.

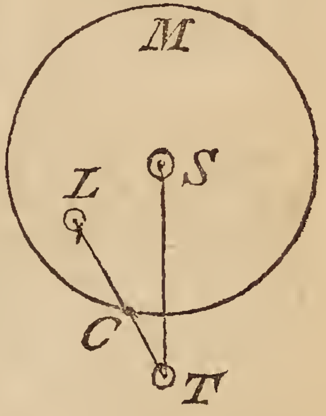
According to Mr. Boyle, the weight of water is to that of air as 1000 to 1. Mr. Ward makes a cubic inch of water to weigh 578697 ounces avoirdupois. Mr. Norwood makes a degree of the great circle = $69\frac{1}{2}$ miles; hence the diameter of the earth is = 504606222 inches fere. And 35840000000000000000 ounces of air will fill the abyſs; and thence 3584019 ..... ounces of water will fill the ſame. Then as 578697 ounces : 1 inch :: 35840, &c. ounces : 61932237423038308475765 = number of inches in the abyſs, which added to thoſe which are in the earth, the ſum will be equal to the ſolid inches in the ſphere of the flooded earth: from the diameter of which take that of the earth, and divide the remainder by 2, the quotient is 77397'7752 inches = 6449'8146 feet = 2149'9382 yards = 1 mile 389 yards.

This anſwer agrees pretty near with the propoſer of the queſtion. There were many others who ſolv'd it: but in anſwers to queſtions of this nature, there will be ſome conſiderable difference, by reaſon the proportions are taken from authors which do not exactly agree; as (1) In the proportion of air to water, (2) In the weight of water, (3) The geometrical miles in a degree, (4) In the diameter to the circumference.

VI. *Queſ-*

* VI. *Queſtion* 128 *anſwer'd by Mr.* T. Williams.

The common center of gravity of the earth and moon goes through the magnis orbis ſo, that the areas deſcribed by the radii to the ſun are proportional to the times; the accelerating gravities are as the quantities of matter in thoſe bodies; the maſs of the earth is given equal to 39008956283823202513476 cubic feet; the diameter of the ☽ to the diameter of the ⊖, as her apparent ſemi-diameter to her horizontal parallax. Hence her magnitude 801682492916446916225 feet: The attractive force will be the ſame in reſpect to their diſtance from the common center of gravity, as in reſpect of the whole diſtance between them.



Let S denote the ſun, MC the magnus orbis deſcrib'd by the common center of gravity of the earth T, and the moon L, C the ☽ in octant, her mean diſtance $60\frac{2}{9}$, ſemi-diameter $=$ 1309095060 feet $= TL$. Now as the ☽ and ⊖ tend to C as to one another, $CT : CL :: $ maſs in L : maſs in T.

Therefore $CT = 26361759$ feet $=$ 4083 miles, and $CL = 1282733200$ feet $= 242752$ miles.

Mr. *Maſon*, the propoſer, anſwers thus: $d =$ mean diameter $= 268923$ miles, $q =$ the quantity of matter in the earth, and $1 =$ ☽, $a =$ diſtance of the common centers from the ſun; $q : 1 ::$ maſs ⊖ : maſs ☽, $qa = d - a$ per ſtatics, and $qa + a = d$; hence $a = \dfrac{d}{q+1} = 5899{\cdot}34$ miles.

Mr.

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* VI. QUESTION 128.

If e be the quantity of matter in the earth, and m that in the moon, or any other two bodies, and d their diſtance aſunder. Then, per ſtatics, as $e + m : d$

$$:: \left\{\begin{array}{l} m : \dfrac{dm}{e+m} = \text{the diſtance of the earth} \\ e : \dfrac{de}{e+m} = \text{the diſtance of the moon} \end{array}\right\} \text{from the common center of gravity.}$$

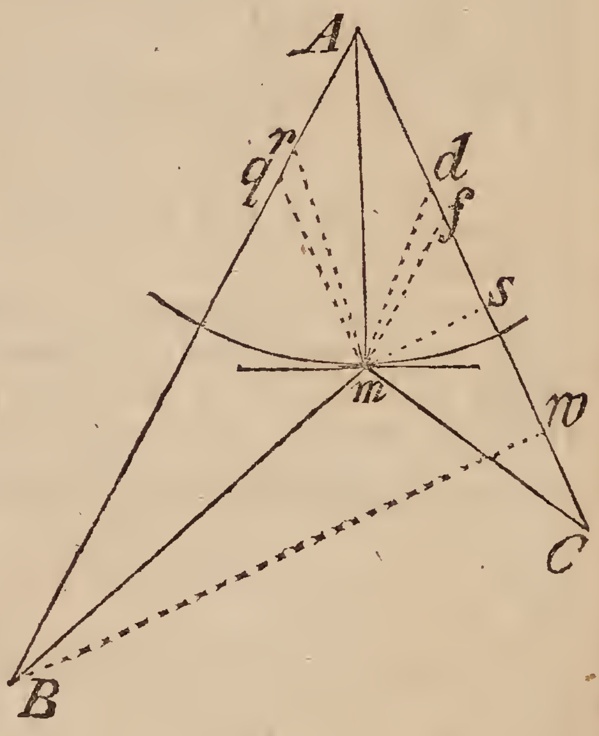
Mr. *Turner* has curiously explain'd this, and says the author ought to have told whether in ♂ or ♀, &c. but that nothing certain can be laid down, since we cannot truly determine the distance and magnitude of the sun; and that regard should be had to their densities, and specific gravities, &c.

* VII. *Question* 129, *answer'd by Mr.* Da. Nairne.

The pendulum vibrates 1000 per hour $= 16\frac{2}{3}$ per minute, and one of 39·2 inches vibrates 60 per minute; also they being in a duplicate ratio of their vibrations, therefore the length of the candlestick will be found 508 inches; and the candlestick above the floor 314. Hence the whole height $=$ 822 inches $=$ 68·5 feet.

The Prize Question answer'd.

Join AB, AC and Am; draw ms and $Bw \perp AC$, $mq \parallel AC$, $mf \parallel AB$; draw md so that $\angle mdA = \angle AmC = AmB$, and mr that $\angle Arm = AmB$. Then the triangles Amb, Amr are similar, as also AmC and Amd: also the triangles rmq, dmf are similar. Then let $a = 108 = AB$, $b = 80 = AC$, $c = 61{\cdot}95 = Aw$, $d = 88{\cdot}47 = Bw$, and $r = 50 = Am$; also $x = As$, $y = ms$. Then $mf = \frac{ay}{d}$, and $Sf = \frac{cy}{d}$,



which

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* VII. QUESTION 129.

As $1000^2 : 3600^2$ or as $10^2 : 36^2 :: 39{\cdot}2 : 39{\cdot}2 \times 3{\cdot}6^2 =$ 508 inches the length of the cord or line.

Again, if $x =$ the whole height, and $a = 508 =$ the greater part. Then $x : a :: a : x - a$; hence $xx - ax = aa$, and $x = \frac{1+\sqrt{5}}{2} \times a = 821{\cdot}96$ inches $= 68\frac{1}{2}$ feet nearly.

which taken from x, we have $Af = x - \frac{cy}{d} = mq$, and $Aq = mf = \frac{ay}{d}$. Again, in the like triangles, Amb, Amr, $Ar = \frac{rr}{a}$; and in AmC, Adm, $Ad = \frac{rr}{b}$, which taken from $Af = x - \frac{cy}{d}$, we have $df = x - \frac{cy}{d} - \frac{rr}{b}$. Alſo $rq = \frac{ay}{d} - \frac{rr}{a}$. Then $mq : qr :: mf : df$, that is $x - \frac{cy}{d} : \frac{ay}{d} - \frac{rr}{a} :: \frac{ay}{d} : x - \frac{cy}{d} - \frac{rr}{b}$; and, croſſing extreams and means, $xx - \frac{2cyx}{d} - \frac{rrx}{b} + \frac{ccyy}{dd} + \frac{rrcy}{db} = \frac{aayy}{dd} - \frac{rry}{d}$; or for $aa - cc$ put dd, and tranſpos'd $\frac{ccyy}{dd}$, &c. comes $x^2 - \frac{2cyx}{d} + \frac{rrx}{d} - \frac{rrx}{b} = yy - \frac{rrcy}{db} - \frac{rry}{d}$. Proceeding finds $x = 45{\cdot}8068 = As$. Then the angle sAm may be found; and two ſides and a contain'd angle given in each, to find $Bm = 70{\cdot}32$, and $Cm = 39{\cdot}63$ feet the anſwer.* *I. T.*

Of

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* *The* PRIZE QUESTION.

This queſtion may be otherwiſe ſolved thus:

Putting $a = AB$, $b = AC$, and $r = Am$, as above; and alſo s and c = ſine and coſ. $\angle BAC$,
x and $\sqrt{1 - x^2}$ = ſine and coſ. $\angle BAm$, and
z and $\sqrt{1 - z^2}$ = ſine and coſ. $\angle CAm$, to the radius 1.

Then, by trigonometry, $\frac{ax}{r - a\sqrt{1 - x^2}}$ = tang. $\angle AmB$, and $\frac{bz}{r - b\sqrt{1 - z^2}}$ = tang. $\angle AmC$; but theſe angles are equal to each other by the queſtion; therefore we have this equation, $\frac{ax}{r - a\sqrt{1 - x^2}} = \frac{bz}{r - b\sqrt{1 - z^2}}$.

But,

Of the Eclipses in 1728.

There will be four eclipses this year; twice will the moon's dark body interpose between the sun and our part of the earth, and hide part of his face from our sight: and twice will the earth interpose between the sun and moon, and hinder the sun's enlightning the moon.

1. Moon eclipsed on Wednesday the 14th day of February, about 7 in the morning, visible.

	Begin. h.	m.	Midd.		End		Digits	
Astronom. Car. at Coventry	V	44	VII	10	VIII	36	9	32
Leadbetter, London —	5	49	7	13	8	48	9	13
Joh. Newton, Melt. Moberry	5	55	7	7	8	19	9	26
T. Sparrow, Nottingham	5	47	7	16	8	45	10	16
☽'s lat. north, descending	39′	47″	——		30′	28″	——	

The

But, again by trigonometry, $z = s\sqrt{1 - x^2} - cx$,

$$\text{and } \sqrt{1 - z^2} = sx + c\sqrt{1 - x^2};$$

these values of z and $\sqrt{1 - z^2}$ being substituted in the above equation, we have $\dfrac{ax}{r - a\sqrt{1 - x^2}} = \dfrac{bs\sqrt{1 - x^2} - bcx}{r - bsx - bc\sqrt{1 - x^2}}$; which equation, reduced, gives

$$4a^2b^2x^4 - 4a^2brsx^3 \begin{array}{l} + a^2r^2x^2 \\ + b^2r^2 \\ - 4a^2b^2 \\ + 2abcr^2 \end{array} \begin{array}{l} + 2a^2brsx \\ - 2ab^2crs \\ \\ \\ \end{array} \begin{array}{l} + a^2b^2s^2 \\ - b^2r^2s^2 \\ \\ \\ \end{array} = 0;$$

from which biquadratic equation x may be found.

The moon will ſet about the middle of the eclipſe, ſo that the end of it will not be viſible to us.*

2. Sun eclipſed the 28th of February, at 8 at night, but inviſible, by reaſon the ſun is then ſet.

3. Moon eclipſed the 8th day of Auguſt, at 5 at night, the moon being then below our horizon. The eclipſe will be over before ſhe riſeth, and ſo inviſible.†

4. Sun eclipſed the 24th of Auguſt, at 1 in the morning, inviſible.

New Queſtions.

I. *Queſtion* 130, *by Mr.* Rich. Whitehead.

Near the place where I ſojourn there happen'd of late,
Thro' time and neglect, a ſharp cauſe of debate.
Three friends own'd a meadow, for ſo many years,
Till they could not determine the bounds of their ſhares.
A worm-eaten parchment, much gone to decay,
Was produc'd, full of lines, which they call'd a ſurvey:
This was thumb'd, and look'd over and over again,
And with ſpectacles too, but alas! all in vain:
Nay, the ſchoolmaſter's learning, tho' deep, nought avail'd;
And where ſhou'd they go when the ſchoolmaſter fail'd?
How'e'er, being told that, my fancy to pleaſe,
I've us'd myſelf often with queries like theſe;

They

* This eclipſe was obſerved

At *St. Michael the Archangel* by *J. de Caſtro Sarmento.*

	h.	m.	s.
Beginning — — — —	14	3	35
End — — — — —	17	0	37

† This eclipſe was obſerved at *Pekin*, thus:

	h.	m.
Beginning of the penumbra —	10	54
Beginning of the eclipſe — —	11	2
End — — — — —	14	0

They all ſaid they'd treat me, and thank me to boot,
If I'd ſet the thing right, and end the diſpute.
The mead had four ſides, a tripezium or ſo,
As the muſty old manuſcript gave me to know:
Theſe ſides, eaſt, weſt, north, and ſouth, as they went,
The letters *A*, *D*, *E*, and *C* repreſent.
A D had ſix chains, forty links, (to go on)
E C twice five chains, links ſix, three, and one;
And *A C* contain'd chains twice ſeven, links none.
Two lines from the ends of the ſide *A* and *C*
Iſſuing, met, on the oppoſite ſide *E* and *D*,
At a point call'd, for ſake of diſtinguiſhing, B,
And there form'd an angle (you know what I mean)
Equal the ſum of ſixty degrees, more by eighteen;
And after this manner were ſeen to divide
Into its three three-corner'd portions the mead.
Moreover, theſe lines their proportion thus bore;
B C to *B A*, was as three is to four;
B D to *B E* the ſame ratio did ſhew,
As three, in the ſcale of proportion, to two.
Phoo! ſaid I, Mr. Pedant, don't know what his trade is;
If nonplus'd by this, he's no great Archimedes.
I ſhall ſoon ſet this matter to rights, I don't doubt;
But I found, after all, I was plaguily out:
I thought of this nature 'twas eaſy to do things,
But I find that ſpeculation and practice are two things.
Of ye, Diarian fair, the favour I aſk,
That you'd pleaſe to perform what I took for my taſk:
For me 'tis too much; but there's nought can ſurprize
Or poſe you, whoſe wits are as bright as your eyes!

II. *Queſtion* 131, *by Mr.* Tho. Dod.

A youth who in numbers ſome progreſs had made,
And took himſelf now for a notable blade,
Came with his progreſſion*, and ſaid he cou'd ſhow,
How far a ball, conſtantly moving, wou'd go;
Which, ſays he, the firſt hour ſhould go forty miles clever,
Thirty-five in the ſecond, and ſo on for ever.
I allow'd he might do it, and bid him ſuppoſe
The ratio as 6 to .... what I nor he knows;
And that it went ſo many † miles ſecond hour:
Likewiſe this ſum to his, be as nine is to four.
He try'd, and fell ſhort, as a long thing to do:
So now he refers himſelf, ladies, to you.

* Geometrical. † $46\frac{12}{36}$.

III. *Queſ-*

III. *Question* 131, *by Mr.* John Hartley.

In ancient times, when royal David's ſon
Did reign in glory at Jeruſalem,
He built the ſpacious temple of the Lord,
With implements, and rich utenſils ſtor'd.
A molten ſea among the reſt was made,
For the prieſt's uſe intended, as 'tis ſaid:
Upon twelve brazen oxen it was ſet:
Two thouſand baths it wou'd contain; and yet
A line of thirty cubits wou'd ſurround
The ſame: It was cylindrical and round.
The depth five cubits was, and hand's breadth thick:
But the diameter I'm to ſeek;
For tho' ten cubits be the number told,
With the periphery this will not hold;
For ſo the circumference you may ſee,
Wou'd thirty-one and more than four-tenths be.
Now, I ſuppoſe, the jewiſh cubit was
Longer than ours; but what's their bath, alas!
Is hard to fix, ſince authors are divided:
But ladies, by your arts 'twill be decided.
My firſt requeſt, fair ladies, don't deny,
The bath's content, and cubit's length deſcry?
And theſe dimenſions how I muſt apply,
To make the ſea two thouſand baths contain,
No arbitrary meaſures to retain,
But what you from an author can maintain.
One favour more, once more I crave your aid;
Suppoſe this molten ſea of copper made,
And full of water pure, I pray, declare
What weight avoirdupois the oxen bear.

IV. *Question* 132, *by Mr.* Tho. Williams.

In Oxfordſhire's a little meadow ground,
A ſection of a parabola found,
Having three ſides; one curv'd, we'll call CM,
Being ſo made by Charwell's chryſtal ſtream:
The other two be'ng ſtreight, did make connexion,
In X the node, or focus of that ſection:
But being ſtreightly hedg'd, the laſt great flood
Drove all that mound from off the ground it ſtood;
Left nothing ſtanding but a willow tree,
And that, by chance, grow'd in the vertex C.

Since

Since which all ways are try'd for to regain
The points *M*, *X*, but all, alas ! prove vain.
But this may uſeful be, the ſide *CX*
Was found, before the flood, poles twenty-ſix ;
The ſquare of which, they ſay, was equal to
The meadow's area. Now we beg of you
To give the ſide *XM*; for till that's found,
We can't again pretend to fix the ground.

V. *Queſtion* 133, *by* Τελώνης Πάλαι.

Ye charming fair ſex, to whom benign heav'n
A bright and ſuperior genius hath given;
Whoſe luſter in wit and art does appear,
In the bright annals of the rolling-year;
Your aid's much deſir'd: And you, ſons of art,
Your kind aſſiſtance pray pleaſe to impart
To a young Philomath, who labours to find
A right-angled triangle of ſuch a kind,
That when the doubled ale area on every ſide
In its utmoſt extent (tho' never ſo wide)
Being duly ſubducted, the remainders all three
(From every ſide) a ſquare number ſhall be.
Now, ladies, and artiſts, pray pleaſe to explain,
When a veſſel's erected upon ſuch a plane,
At ten inches depth, how much ale 'twill contain.

VI. *Queſtion* 134, *by Mr.* Tho. Grant.

Ye Britiſh ladies, to whom all apply,
As an oracle, in things abſtruſe;
The greateſt area that can b' inclos'd
By four right lines, ſuch as below are ſeen,
Vouchſafe to tell: for ſurely you, or none,
The deep myſterious ſecret can reveal.

[The lines 20, 16, 12, and 10.]

VII. *Queſtion* 135, *by Mr.* John Turner.

In that delightful iſle of old ſo fam'd
For Cytherea's rites, thence Paphos nam'd;
Inclos'd with flow'ry meads, a mountain ſtands,
That caſts a ſhadow into diſtant lands:
In vain acceſs by human feet is try'd,
Its lofty brow looks down with noble pride

On

On fruitful Nile, tho' ſeven wide channels ſpread,
And ſees old Proteus in his oozy bed:
Whoſe altitude if cub'd and multiply'd
Into three times the ſquare root of the ſide,
Drawn from the mountain's vertex (till it be
A tangent to the earth's convexity,
Bounding the utmoſt proſpect of the view)
Produces what I in the margin ſhew. [1005·9309 miles
If now the earth's radius ſuppoſed be
In miles three thouſand nine hundred ſixty-three, [3963
Artiſts, the mountain's height explain,
Above the horizontal plain.

The Prize Queſtion.

Bold Britons, boaſt no more of Bacchus here,
Since he's dethron'd by Parſon's humming beer;
Straight abdicate him our dominions quite,
And Parſons deify, as 'tis his right.
Let foreign dregs no more our ſenſe invade,
Which robs our ſtores, and ſpoils domeſtic trade:
Champaign, Bourdeaux, and Burgundy no more
Will be eſteem'd as they have been before;
His ſov'reign, ſtout, and fine balſamic ale
Excels that nectar did the gods regale.
For ſack no more the learned can inſpire
Like this ſame beer, with true poetic fire.
'Twill make the courtier hate the fawning knave;
The tim'rous ſoldier, valorous and brave;
The canting whig, ſelf-int'reſt to deſpiſe;
And heedleſs tories, to become more wiſe;
Make the mechanic new inventions find,
And will inſpire true Britons with one mind.
Henceforth, renowned Parſons, you ſhall be
Eſteem'd our patron, own'd a deity.
Your ſtately caſk to be your throne, from whence,
To all your votaries, your laws diſpenſe.
This ſpheroid caſk, whoſe magnitude is ſuch,
The Trojan horſe did not contain ſo much;
For, by th' dimenſions, it does plain appear
To hold twice eighty * barrels of ſtrong beer:
Alſo the head's the latus rectum of its ſphere.
If you the diagonal from th' length ſubtract,
Two feet two inches then remain exact.
Ingenious artiſts, I this favour aſk,
To ſhew th' dimenſions of this ſpacious caſk.

* 160 barrels at 36 gallons to the barrel.

Queſtions

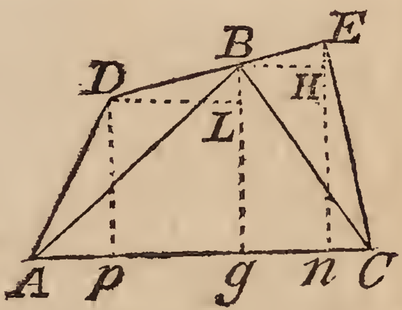
1729.

Questions answer'd.

* I. *Question* 130 *answer'd by Mr.* Turner.

HAving AC given $=$ 14 chains, the angle $ABC = 78°$ and the ratio BA to BC as 4 to 3. It is eafy to find $BA = 12{\cdot}51881$, and $BC = 9{\cdot}38912$. Draw the lines as in the fcheme, and put

$DA = b = 6{\cdot}4$,
$Ag = g = 9{\cdot}4487$,
$gC = m = 4{\cdot}5512$,
$gB = h = 8{\cdot}2123$,
$EC = n = 10{\cdot}1$,
$nC = a$?
$Ap = e$?
$EH = y$?



Then

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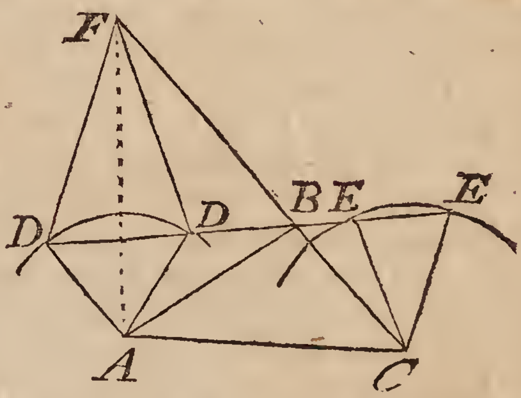
* I. QUESTION 130.

Here being given of the trapezium the three fides AD, AC, and CE, the angle ABC formed in the other fide, the ratio (m to n) of its legs AB, BC, and the ratio (p to q) of the fegments BD, BE of the other fide; from which the figure will be conftructed thus :

Conftruction.

On the given bafe AC (by Prob. 3 of Simpfon's Algebra) conftitute a triangle ABC whofe fides fhall be in the given ratio of m to n, and whofe vertical angle fhall be equal to the given one. Then with the centers A and C, and radii equal to the other two given fides of the trapezium, defcribe two circles. Produce CB, and make as $q : p :: CB : BF$ and alfo $:: CE : FD$; which apply to the circumference of the circle whofe center is A. Draw DB, and continue it to meet the circumference of C in E; and $ADEC$ is the trapezium required.



Demon-

Then $2 : 3 :: m - a : g - e$ per queſtion.
$4bb - 4ee = 4hh - 12hy + 9yy$ per Euclid 47. 1.
$9nn - ss - 4se - 4ee = 9hh + 18hy + 9yy$:
Putting $s = 3m - 2g$, and $w = 9nn - ss$,
We ſhall have $y = 2h - 2\sqrt{ab - ee}$,

$$\text{and } y = \sqrt{\frac{w - 4se - 4ee}{9}} - h.$$

And reducing the equation, $e = 3{\cdot}43139$, y is found $= 1{\cdot}87239$, $a = 0{\cdot}53966$. Hence $BD = 6{\cdot}6411$, and $BE = 4{\cdot}4274$ chains, and the whole $DE = 11{\cdot}06850$.

		A.	R.	P.
And the areas of	$ADB =$	1	0	22·7667
	$ABC =$	5	3	1·3731
	$CBE =$	2	0	11·7145

Mr. *R. Fearnſide*'s anſwer is the ſame in every individual letter.

II. *Queſ-*

Demonſtration.

The triangles BCE, BFD are ſimilar by Eucl. VI. 7, and therefore $BE : BD :: BC : BF :: q : p$ by the conſtruction; and the reſt is alſo evident from the conſtruction.

Calculation.

As $m + n : m - n ::$ cotang. $\frac{1}{2} \angle ABC$: tang. $\frac{1}{2}$ dif. of the angles BAC, BCA at the baſe; which added to and taken from half their ſum, we obtain thoſe angles themſelves; and conſequently the triangle ABC becomes all known, which is one part of the field.——Then in the trapezium $BADF$, are known all the ſides and the $\angle ABF$; to find the diagonal BD; for AD is given, and AB and the $\angle B$ have been found; then by the conſtruction $q : p :: \left\{ \begin{matrix} CB : BF = \frac{p}{q} \times CB \\ CE : DF = \frac{p}{q} \times CE \end{matrix} \right\}$. To determine BD, draw AF; then in the triangle ABF, given two ſides AB, BF, and their included $\angle$, to find the third ſide AF and the $\angle AFB$. Then in the triangle ADF, are given all the ſides, to find the $\angle AFD$; and the ſum or difference of AFB and AFD will be the $\angle DFB$. Wherefore in the triangle DFB, are known two ſides DF, FB, and their included angle, and conſequently the whole triangle; which is the 2d portion.——Laſtly, as $m : n :: DB : BE$; hence the 3d portion CBE is known.

II. *Question* 131 *answer'd by Mr.* Tho. Grant.

A ball moving 40 miles the firſt hour, 35 the ſecond, and ſo on for ever in the ſame ratio, will go 320 miles. Then, by the queſtion, as 4 : 9 :: 320 : 720 miles = the ſum of a decreaſing geometrical progreſſion, whoſe ſecond term is $46\frac{10}{36}$ and laſt term = 0. Let x = the firſt term of the ſame; then, per Euclid 5. 12, 'twill be as $x : 46\frac{10}{36} :: 720 : 720 - x$. This, turned into an equation, gives $720x - xx = 33500$; whence $x = 50$ miles, and the common ratio as 6 to $5\frac{7}{12}$ or as 1 to $\frac{67}{72}$. *Q.E.I.*

III. *Question* 131 *answer'd by Mr.* Turner.

If a line of 30 cubits, or 656·64 inches, would ſurround the molten ſea on the outſide; then the outſide diameter was but — — — — 209·015 inches

Twice the thickneſs of the copper or 2 hand br. ſub.	7·296
Remains the inſide diameter —	201·719
The depth 109·44 inches, area of the baſe	34311·982
The whole ſolid content from outſide	3755103·31 cubic inches
Add the copper's bottom —	125170·11
The ſum is — — —	3880273·42
Content of the inſide — —	3497523·126
Difference — — —	382750·294

Equal to the cubic inches of copper. Divide the laſt ſum but one by 2000, the number of baths it contained, gives the quotient 1748·76 cubic inches the content of one bath $= 7\frac{6}{10}$ gallons wine meaſure; the whole contained 15140·8 gallons wine meaſure, or 60 tuns 20 gallons. Then accord-cording to Mr. Ward,

A cubic inch of { copper weighs 5·208369 / clear water 0·578697 } ounces avoird.

Hence the weight of		tuns	hund.	pounds
	water	56	8	12
	copper	55	12	40	13
	on the oxen	112	0	52	13

Q. E. I.

Anſwer'd

Anſwer'd by Mr. John Clark.

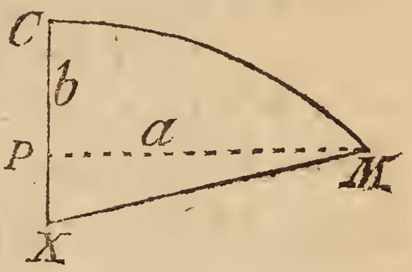
By Harris's Lexicon a { cubit is 21·888 inches; palm 3·648; bath 1747·700 }

By Harris's Lexicon a	cubit is	21·888 inches
	palm	3·648
	bath	1747·700
whence the quantity of 2000 baths		3495400
water in the ſea		3497504
difference		2104, which is but

$\frac{6}{100}$ of an inch in the depth, or little more than one bath.

	T.	c.	ſt.	lb.	dw.	gr.
Then by Mr. Boyle's proportion the wt. of water is —	57	0	5	11	205	8
ſides of the copper	37	2	7	4	59	16
and the bottom in proportion to the ſides	18	1	0	1	173	9
The whole weight in avoirdupois —	112	4	5	4	146	9

* IV. *Queſtion* 132 *anſwer'd by Mr.* W. Milward.



Let fall the ordinate MP, which call a, and put $CX = b = 26$ poles. As $4b : a :: a : \frac{aa}{4b} = CP$ per conics. $\frac{2CP \times PM}{3} =$ the area of the ſemi-parabola $CPM = \frac{2aaa}{12b}$ or $\frac{aaa}{6b}$.

$CX - CP = PX = \frac{4bb - aa}{4b}$, and

$PX \times \frac{1}{2} MP =$ the area of the triangle PXM.

The $\triangle PXM +$ area of the ſemi-parabola = the area of the meadow, viz. $\frac{aaa}{6b} + \frac{4bba - aaa}{8b} = bb$ per queſtion.

$aaa + 12bba = 24bbb$; here a is $= 42{\cdot}55$ poles.

Hence $MX = 43{\cdot}445$.

V. *Queſ-*

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* IV. QUESTION 132.

Putting $b = CX$, and $x =$ the ordinate PM; then, by the nature of the parabola, $CP = \frac{x^2}{4b}$; and, by prob. 7 page 321 Menſuration, $\overline{CX + \frac{1}{3}CP} \times \frac{1}{2}PM =$ the area $= b^2$ by the queſtion; that is, $\overline{b + \frac{x^2}{12b}} \times \frac{1}{2}x = b^2$, or $x^3 + 12b^2x = 24b^3$.

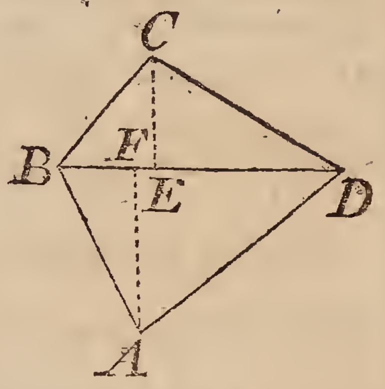
* V. *Queſtion* 133 *anſwer'd by Mr.* Geo. Brown.

Let $a =$ ſide of the triangle; then $\frac{2aa}{282} =$ the double area. And ſuppoſe $a - \frac{2aa}{282} = 4$; which will admit of many anſwers, for when brought to a ſolution it will be $a - 70{\cdot}5 = \sqrt{4970{\cdot}25 - 564}$, and the greateſt root take to be the utmoſt extent mentioned, viz. $a = 705 + \sqrt{4970{\cdot}25 - 564} = 136{\cdot}879$. And making this equation for the other ſide $a - \frac{2aa}{282} = 2{\cdot}25$; then $a = 138{\cdot}71$. And a veſſel erected upon ſuch a plane, at 10 inches deep, contains 334·49 ale gallons.

† VI. *Queſtion* 134 *anſwer'd by Mr.* Tho. Grant.

Let $x = BD$, $a = AD$, $b = AB$, $c = CD$, and $d = BC$.

1. By the figure,



$x : a + d :: a - d : \frac{aa - dd}{x} = DF - BE$, therefore $DF = \frac{xx + aa - dd}{2x}$.

2. Again by the figure,

$x : c + b :: c - b : \frac{cc - bb}{x} = DE - BE$, therefore $DE = \frac{xx + cc - bb}{2x}$.

3. By

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* V. QUESTION 133.

It is not clear what is meant by this queſtion as it is worded; if double the area of the triangle is to be taken from each ſide, and the three remainders are to be ſquares, then ſolutions are given at queſtion 638.

† VI. QUESTION 134.

By Theorem 12 of Simpſon on the Max. and Min. of Geometrical Quantities, the trapezium will be greateſt when it can be inſcribed in a circle; and then, by rule 5 page 72 of my Menſuration, the area will be found thus: Half the ſum of the given ſides is 29, from which each of the ſides being taken, we have the four remainders 9, 13, 17, 19; and the area $= \sqrt{9 \times 13 \times 17 \times 19} = 194{\cdot}4$.

3. By Eucl. I. 47.

$$\sqrt{\frac{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4}{4xx}} = FA.$$

4. By the same,

$$\sqrt{\frac{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4}{4xx}} = EC.$$

5. By the figure,

$$\tfrac{1}{4}\sqrt{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4} +$$
$$\tfrac{1}{4}\sqrt{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4} = \text{the}$$
greatest area.

6. The last in fluxions,

$$\frac{a^2x\dot{x} + d^2x\dot{x} - x^3\dot{x}}{2\sqrt{2a^2x^2 + 2d^2x^2 + 2a^2d^2 - x^4 - a^4 - d^4}} +$$
$$\frac{c^2x\dot{x} + b^2x\dot{x} - x^3\dot{x}}{2\sqrt{2c^2x^2 + 2b^2x^2 + 2c^2b^2 - x^4 - c^4 - b^4}} = 0.$$

7. This reduced is

$$\left.-x^8 \begin{matrix}+2a^2\\+2b^2\\+2c^2\\+2d^2\end{matrix}\, x^6 \begin{matrix}-a^4\\-b^4\\-c^4\\-d^4\\-4a^2b^2\\-4a^2c^2\\-4b^2d^2\\-4c^2d^2\end{matrix}\, x^4 \begin{matrix}+2a^2b^4\\+2a^2c^4\\+2a^4b^2\\+2a^4c^2\\+2b^2d^4\\+2b^4d^2\\+2c^2d^4\\+2c^4d^2\end{matrix}\, x^2 \begin{matrix}-b^4a^4\\-b^4d^4\\-c^4d^4\\-c^4a^4\\+4a^2b^2c^2d\end{matrix}\right\} = 0.$$

8. Or in numbers

$$-x^8 + 1800x^6 - 1076272x^4 + 222272000x^2 - 8768000000 = 0.$$

Hence $x = 21{\cdot}187$. And the greatest area is $194{\cdot}4$, &c.

VII. *Question* 135 *answer'd by Mr.* John Bulman.

Let $x = BA$ = the mountain's height.
Then $x + 3963 = AC$.
Hence $xx + 7926x + 15705369 = AC^2$.
Or $xx + 7926x = AM^2$.

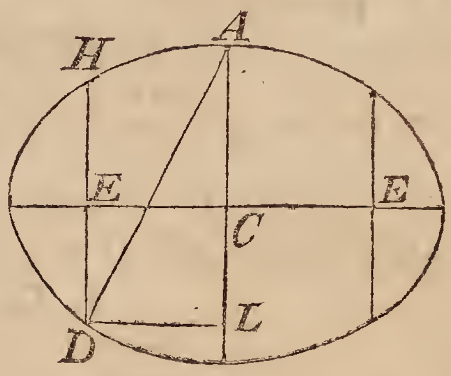
See Fig. to Quest. 101 *p.* 244.

Consequently $\sqrt[4]{81x^{14} + 642006x^{13}} = 1005{\cdot}9309$.
Then if the latter part of the equation at the last step be involv'd to the fourth power, and the radical sign taken away from the first part, the equation will be clear of surds, and x may be found = 3 miles, the mountain's height required.

The same answer'd by Mr. R. Fearnside.

Put $a = AB$, $b = CB = 3963$, $e = AM$, $c = 1005{\cdot}9309$. Then $3a^3\sqrt{e} = c$, and $e = \frac{cc}{9a^6}$. Then $ee = 2ba + aa = \frac{c^4}{81a^{12}}$, or $a^{14} + 2ba^{13} = \frac{c^4}{81}$; reduced, $a = 2{\cdot}999999$ miles.

The Prize Question answer'd by Mr. Geo. Brown.



Let $AC = a$, $CE = LD = x$, $EE - AD = b = 26$ inches, $d = 5760$ the content, $c = 1077{\cdot}15$.
$4xx - 4bx + bb = AD^2$.
$\sqrt{3xx - 4bx + bb} - a = DE$.
$3xx - 4bx + bb + aa - 2a\sqrt{3xx - 4bx + bb} = DE^2$.
$12xx - 16bx + 4bb + 4aa - 8a\sqrt{3xx - 4bx + bb} = DH^2$.

$$\frac{24x^3 - 32bx^2 + 8bbx + 24aax - 16ax\sqrt{3xx - 4bx + bb}}{c} = d.$$

$24x^3 - 32bx^2 + 8bbx + 24aax - dc = 16ax\sqrt{3xx - 4bx + bb}$, and when squar'd $576x^6 - 1536bx^5 + 1408b^2x^4 + 1152a^2x^4 - 512b^3x^3 - 48dcx^3 - 1536ba^2x^3 + 64b^4x^2 + 64bdcx^2 + 384b^2a^2x^2 + 576a^4x^2 - 16dcx - 48dca^2x + d^2c^2 = 768a^2x^4 - 1024ba^2x^3 + 256b^2a^2x^2$.

And when aa is found in the unknown quantity x, there will be an equation of the 12th power adfected; from whence the length is 156·2, diagonal 130·2, bung diameter 128·3, and head 82·1. *Q. E. I.*

Others have answer'd it as below.

	Length	Diag.	Bung	Head
Mr. *John Bulman* — —	157·25	131·25	128·8	81·72
Mr. *James Clarke* — —	160	134	127	88
Mr. *John Rosser* — —			126·01	76·5
Mr. *John Finch* — —	157		128·19	81·5
Mr. *John Side-Bottom* —	163	137		81·5
Mr. *John Hampson* — —	157		128	81

The lot of 10 diaries fell to Mr. *J. Finch*, of Worcester.

Of

Of the Eclipſes in 1729.

There will be five eclipſes this year: Three times will the dark body of the moon interpoſe between the ſun and our earthly globe; and twice does the earth come between the ſun and the moon, and hinder his rays from enlightning the moon.

1. Sun eclipſed on Saturday the 18th of January, at 6 in the morning, inviſible to us by reaſon the ſun is not riſen.

2. Moon eclipſed on Candlemas-day, the 2d of February, at 3 quarters after 8 at night, total and viſible.*

	Begin.	Begin. tot. da.	Middle	End of tot. da.	End	Dura.	Digits
Aſtron. Carol. Coventry	VII 4	VIII 3	VIII 50	IX 37	X 36	III 32	19 30
Chattock, Lond.	7 0	8 1	8 52	9 44	10 45	3 44	20 0
Leadbetter, dit.	6 57	7 58	8 44	9 30	10 31	3 33	19 17
J. Newton, Fl. Ta. Melt.	7 4	8 4	8 53	9 41	10 41	3 37	19 46
J. Bulman, Roch.	7 12	8 11	8 58	9 45	10 44	3 32	19 31
Urania, N.Pag.	6 55	7 55	8 40	9 55	10 25	3 30	10 20

3. Sun eclipſed the 16th day of February, at 9 at night, but inviſible, the ſun being then ſet.

4. Sun eclipſed on the 15th of July, inviſible, being at 1 in the morning, when the ſun is below our horizon.

5. Moon

* This eclipſe was obſerved thus:

Place	Obſerver	Beginning	Tot. Im.	Emerſion	End
		h. m. s.	h. m. s.	h. m. s.	h. m. s.
Near Carricfergus in Irela	A. Dobbs Eſq.	6 29 30	7 30 15	9 8 30	App. Time
Rome —	J.B.Carbone	7 44 22	8 43 17	10 21 38	11 20 41 tr.
Paris —	— —	7 3 0		9 41 18	10 41 24
Pekin —	— —	14 38 30	15 39 0	17 17 10	18 17 40

5. Moon eclipsed, total and visible, with continuance, on Tuesday the 29th of July, at 1 in the morning.*

	Begin.	Beg.to dark.	Mid.	End to dark.	End	Durat.	Digits
Astron. Carol. Coventry	XI 15	0 14	I 1	I 48	II 47	III 32	19 5
Leadbetter, Lond.	11 33	12 33	1 19	2 5	3 5	3 32	18 47
Chattock, Covent.	11 19	12 20	1 11	2 2	3 3	3 44	19 45
J. Newton, Mel. Moberry	11 14	12 14	1 3	1 51	2 51	3 37	19 13
J. Bulman, Roch.	11 22	12 21	1 8	1 55	2 54	3 32	19 7
Urania, Newport	11 34	12 35	1 20	2 5	3 6	3 32	19 20

New Questions.

I. *Question* 136, *by Mr.* John Bulman.

When grateful heaven did on Henry smile,
The seventh of that name who rul'd this isle,
The mighty monarch (with an awful hand)
Two courtiers (known for treason) did command
That one to York, thrice fifty miles in length
From London; the other he to Stilton sent
From thence; (which places north of London lay)
They shou'd from the same moment take their way.
From thence a journey of a week they went,
Directly north, as by the King's consent:
Between the foremost man and London found,
By the last trav'ler, the space of ground,
Must in extreme and mean ratio run
As well at last, as when it first begun.

By

* This eclipse was observed thus:

Place	Observer	Beginning h. m. s.	Tot. Im. h. m. s.	Emersion h. m. s.	End h. m. s.
Wirtemb.	J. Weidler	12 1 30	13 1 0	14 40 30	15 40 0
Rome	— —	12 1 0	13 0 16	14 38 24	15 38 0
Padua	J. Poleni	12 0 28	12 58 48	14 37 38	15 38 8 ap.t.
Bononia	E. Manfredi	11 56 54	12 55 52	14 34 25	15 35 0 tr.t.
Barbado.	Mr Stevenson	— — —	8 11 0	9 51 0	10 50 0 ap.t.

By Stilton then alſo the diſtance ſhall
Be in extreme, and mean proportional,
Between London and York; and to take place
To York, from Stilton is the greater ſpace.
Fair ladies, then tell me by algebra,
Th' ratio of the ſwiftneſs of their way,
And from London to Stilton tell I pray.
And from York to Stilton 'tis intended
The miles to know, and this work is ended.

II. *Queſtion* 137, *by Mr.* John Simmons.

The wine gallons that each body platonic will hold,
(The ſides twenty-nine inches) ſome years ſince was told.
A wager is laid me, were each ſide an inch more,
'Twould puzzle my noddle, the ſame to explore.
I've try'd many ways, but in vain, for I find
My money is loſt, if not help'd by ſome friend,
On whoſe ſkill, in the caſe, I may ſafely depend.
Now, gentlemen gaugers, pray ſhew me your art,
And in the next Diary be pleas'd to impart,
What each body wou'd hold, were a globe in its belly
(The ambient ſides touching;) and alſo pray tell me
The number of gallons each ſphere will contain,
That wou'd nicely incloſe each body — make plain.

III. *Queſtion* 138, *by Mr.* Tho. Grant.

When Argo, fraught with the inchanted prize,
With Grecian heroes, and with Medea wiſe,
Had weigh'd her anchor, and her canvas ſpread,
A golden apple at the fore-maſt-head
Sublime they place; their vict'ry to proclaim.
They ſail in triumph o'er the paſſive main,
With equal pace; when, by miſchance, the ball
In three half ſeconds to the deck did fall;
During which time they plow the yielding deep,
The length of five and twenty Grecian feet.
Now tell me, ladies, who have arts at will,
The ſpace's length thro' which the trophy fell?

IV. *Queſ-*

IV. *Question* 139, *by Mr.* Tho. Williams.

Not far remov'd from fam'd Oxford, the eye
And Athens of our British isles, doth lie
A little right-lin'd field triangular,
Whose pregnant mould uberous crops does bear.
This, by a father's will, I must divide
Betwixt two sons, who will not be deny'd;
Because they've heard much of my boasted skill,
How I with ease such problems cou'd fulfil:
For I am apt to talk more than I know,
As most conceited fools are wont to do.
Now, to distinguish angles, we will call
Them A, B, C, in manner as they fall:
A, that is known; the side AB is giv'n;
One eighty-two degrees, t'other chains thrice sev'n:
From A the parting fence must go to D,
Cutting the angle A, and side BC,
That BAD, to DAC, may in
Proportion be, as twelve is to eighteen:
And that BD to DC, may also
Be in the ratio just of three to two.
Hence, I'm to shew what lengths each side will bear,
And how much land will fall to each son's share.
I know it may be done, but cannot do't,
Nor will my boasted rules here help me out;
So, ladies, with submission I implore
Your aid this once, and I will ask no more:
For you or none (whose wits so bright appear)
Can keep my credit up, now lost so near.

V. *Question* 140, *by Mr.* John Lowe.

Suppose there be a pyramid erected upon a triangular base, whose longest side is eighty-eight inches, and the angle opposite to the longest side is eighty-five degrees and one minute, and the rectangle of the other two sides added to their sum is four thousand one hundred and three inches; and the pyramid's greatest angle of altitude, is in proportion to its least, as seven is to six: What is the difference, in ale gallons, betwixt the greatest cylinder and sphere that may be inscribed in the said pyramid?

VI. *Ques-*

VI. *Question* 141, *by Mr.* Will. Browne.

What three numbers are thoſe, ladies, do you ſuppoſe,
 That the ſquare of the firſt, and indeed,
The rectangle of the firſt and the ſecond may juſt
 Make the ſum of a ſcore, is agreed?
And the ſecond, you muſt know, being ſquar'd, as you go,
 And the product of the ſecond and third,
Will make a whole ſcore, and half a ſcore more,
 When added, I'll give you my word.
And the third, pray regard, when as it is ſquar'd,
 And the firſt in the third multiply'd,
The ſum will make out, two ſcore, without doubt,
 Algebra will ſhew you, when try'd?

VII. *Question* 142, *by Mr.* John Ingleborough.

The great tun at Heidelberg, an author ſays, held as much wine in its entrails as the Coloſſus of Rhodes held water between its thighs. It is 31 feet long, and 21 high.

Now ſuppoſing the tun to be of the ſame ſhape with Parſons's caſk, mentioned laſt year, ſo far as may agree with the dimenſions above; how many gallons of wine wou'd it contain? Secondly, ſuppoſing Parſons's caſk of ſtout to equiponderate with the Heidelberg tun of wine, ſuſpending from a ballance 60 feet long; what wou'd the difference of the brachia of the balance be? And thirdly, ſuppoſing it were requir'd that each veſſel ſhou'd evacuate itſelf exactly in two hours by a hole in the loweſt place; what muſt the diameter of each bore be, that ſo the veſſels may hang in equilibrio all the time the liquor is running out, not admitting the weight of the veſſels to interfere or make any variation?

The Prize Question.

A certain courier being at Montpelier,
 (So fam'd for its excellent ſpaw)
Ere that place he leaves, an order receives,
 Expreſs unto Turin to go.
Now its very well known, that the river of Rhone,
 Which betwixt the two places doth lie,
Runs due north and ſouth, quite down to its mouth,
 Through Provence and through Dauphiny:

Mont-

Montpelier, 'tis manifeſt, lies forty miles weſt,
And no more, from the river of Rhone;
And Turin is plac'd one hundred and fifty due eaſt,
From the ſame, as with eaſe may be ſhown.
Likewiſe the true ſpace, from that to this place
(Becauſe that we ought to define)
Is two hundred miles juſt*, (if fame we may truſt)
When meaſur'd upon a ſtreight line.
Now the gentleman knows, that as long as he goes
On the weſtern ſide of the river,
It is in his power, to ride three miles on hour,
If he but exert his endeavour.
But on the orient he muſt be content,
(When he has done all in his power,
It being a tedious and troubleſome way)
To take up with two miles an hour.
Now, ladies, diſcover, the point to paſs over,
That the river ſuch wiſe may be croſt,
That he may proſecute his journey throughout,
And the feweſt of moments be loſt?
That's, what may be the intermediate ſpace
From the ſaid point to each reſpective place.

* 200 miles from Montpelier to Turin.

1730.

Queſtions anſwer'd.

I. *Queſtion* 136 *anſwer'd by Mr.* Rob. Fearnſide.

THE diſtance between York and London given 150 miles; from London to Stilton will be eaſily found 57·2949 miles; and Stilton to York 92·7051. Put y = the ſpace paſſed

* I. QUESTION 136.

The meaning of this queſtion is, To divide 150 miles into two parts in extreme and mean proportion; and to find the ratio of the equable velocities, by which the leſs part and the whole length may be paſſed over in the ſame time.

Put

passed over by the courtier bound to Stilton, in any moment of time; and $x =$ the space passed over by him bound for York in the same moment of time. Then, per question, $xx - 2xy + yy = xy$, in fluxions $2x\dot{x} - 3x\dot{y} - 3y\dot{x} + 2y\dot{y} = 0$. Reduced to an analogy, $\dot{y} : \dot{x}$ (the fluxion of any flowing quantity being taken for its velocity) $:: 2x - 3y : 3x - 2y$. That is, as 128·1242 to 335·4161.

II. *Question* 137 *answer'd by Mr.* Tho. Grant.

Names of the bodies	Capacities	Inscrib'd spheres	Holds besides the spheres	Ambient spheres content
	Win. gall.	Win. gall	Win. gall.	Win. gall.
Tetrahedron	13·77	4·16	9·61	112·43
Hexahedron	116·88	61·20	55·68	318·00
Octohedron	55·09	33·08	22·01	173·09
Dodecahedron	895·69	676·00	219·69	1347·09
Icosahedron	255·00	211·34	43·65	421·17

Mr.

Put $x =$ the less part, and $a = 150$ the whole. Then $a - x$ = the greater part; and, by the question, $x : a - x :: a - x : a$; hence $ax = a^2 - 2ax + x^2$, and $x = \frac{3 - \sqrt{5}}{2} \times a =$ the less part. Therefore $a - x = \frac{\sqrt{5} - 1}{2} \times a =$ the greater part.——Hence

The two parts of any quantity which is divided into extreme and mean proportion, are in the ratio of $\frac{3 - \sqrt{5}}{2}$ to $\frac{\sqrt{5} - 1}{2}$, or of $3 - \sqrt{5}$ to $\sqrt{5} - 1$, or of 1 to $\frac{\sqrt{5} + 2}{2}$, or of $\frac{\sqrt{5} - 2}{2}$ to 1.

And the less part to the whole, as $\frac{3 - \sqrt{5}}{2}$ to 1; which is the ratio of their velocities or rates of travelling required.

* II. QUESTION 137.

In the *Scholia* at page 403, &c. of my Mensuration, the true values of the content of each regular solid, with that of the radius of the inscribed and of the circumscribed sphere, are expressed in terms of the linear edge or side; whence the numbers, as above, may be easily found.

Mr. *Grimmet*, Mr. *Hurd*, Mr. *Bulman*, Mr. *Sidebottom*, Mr. *Colbourn*, Mr. *Brooke*, Mr. *England*, Mr. *Brown*, Mr. *Bruin*, Mr. *Sparrow*, Mr. *Lovat*, Mr. *Eyre*, Mr. *Fairchild*, Mr. *King*, Mr. *Armſtrong*, Mr. *Batterſbee*, Mr. *Hale*, Mr. *Maſon*, and ſeveral others, anſwer'd this queſtion.

* III. *Queſtion* 138 *anſwer'd.*

The ball deſcending with a compound force, that is, an horizontal force by the motion of the ſhip, and by the force of gravity; the ſpaces deſcribed by ſuch motions are analogous to the abſciſſas and their reſpective ſemi-ordinates, in the conic parabola, and the motion will be in the curve of the ſame.

Then there is given the abſciſſa $= x = 434{\cdot}25$ inches = the ſpace deſcribed in three half ſeconds by the force of gravity only; and its ſemi-ordinate $= y = 25$ Grecian feet $= 302{\cdot}1$ inches Engliſh. Whence by fluxions

$$x + \frac{5y^2}{8x} + \frac{3y^4}{128x^3} - \frac{3y^6}{256x^5} + \frac{y^8}{2048x^7} \text{ \&c.} = 567{\cdot}42 \text{ inch.}$$

or $47{\cdot}285$ feet, the ſpace the ball deſcended.

IV. *Queſ-*

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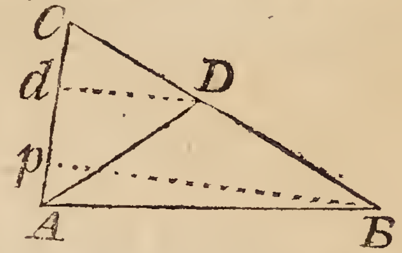
* III. QUESTION 138.

The 25 Grecian feet are $= 25 \times 1{\cdot}007$ or $25{\cdot}175$ Engliſh feet = the horizontal motion, or the ordinate of the parabola, which call $2y$; and as $1^2 : \overline{\tfrac{3}{2}}^{\,2}$, or as $4 : 9 :: 16\tfrac{1}{12}$ feet : $36\tfrac{3}{16}$ feet = the perpendicular deſcent, or the abſciſſa of the parabola, which call x. Then, by Cor. 1 page 310 of my Menſuration, the true length of the curve will be $\sqrt{x^2 + y^2} + \frac{y^2}{x} \times$ hyp. log. of $\frac{x + \sqrt{x^2 + y^2}}{y} = 45{\cdot}9578$ feet = the length of the line deſcribed by the ball.

* IV. QUESTION 139 *anſwer'd by Mr.* Rob. Fearnſide.

Put $AB = 21$ chains $= b$, the natural ſine of the angle BAC (the radius being an unit) $= 82° = 0{\cdot}990268 = t$, the natural ſine $\angle CAD = 49°\ 12' = {\cdot}756995 = s$; and $BC = e$.



Then as $e : t :: b : \frac{bt}{e} =$ ſine $\angle ACD$. Again, as $s : CD\ (= \frac{2}{5}e) :: \frac{bt}{e} : AD = \frac{2bt}{5s} = 10{\cdot}988$. On AC let fall the perpendicular Bp. And ſay as $b : 1 :: t : Bp = 20{\cdot}795$. Conſequently Dd is $= 8{\cdot}318 = \frac{2}{5}Bp$, $CD = 13{\cdot}1837$, the area of the $\triangle ACD = 4{\cdot}166$ acres, and of the $\triangle ADB$ is $= 6{\cdot}249$ acres.

V. QUES-

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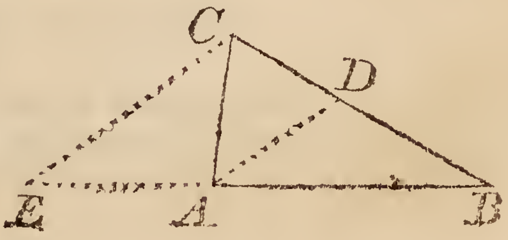
* IV. QUESTION 139 *calculated otherwiſe.*

The $\angle BAD = \frac{2}{5}$ of $82° = 32°\ 48'$, whoſe ſine call a; and $\angle CAD = \frac{3}{5}$ of $82° = 49°\ 12'$, whoſe ſine call s; alſo $t =$ s. $\angle BAC$ or $82°$, and $b = AB = 21$ chains as above. Then, alſo as above, $AD = \frac{2bt}{5s} = 10{\cdot}9885$: And hence $\frac{1}{2}AB \times AD \times$ s. $\angle BAD$ or $32°\ 48' = \frac{abbt}{5s} = 62{\cdot}502$ ſquare chains $= 6{\cdot}2502$ acres $= \triangle ABD$.

Again, as $AB + AD : AB - AD ::$ cot. $\frac{1}{2} \angle BAD$ or cot. $16°\ 24'$: tang. $\frac{\angle ADB - \angle B}{2} = 45°\ 5'$; which added to $73°\ 36'$ half the ſum of theſe two angles, we have $118°\ 41' =$ the $\angle ADB$; and this taken from $180°$, there remains $61°\ 19'$ for the $\angle ADC$. Then, as s. $\angle BDA$: s. $\angle BAD :: AB : BD = 12{\cdot}967$; the 2-3ds of which is $DC = 8{\cdot}645$. Hence $\frac{1}{2}AD \times DC \times$ s. $\angle ADC = 41{\cdot}648$ chains $= 4{\cdot}1648$ acres for the other part ACD. And, laſtly, as s. $\angle CAD$: s. $\angle D :: CD : CA = 10{\cdot}0135$.

Conſtruction.

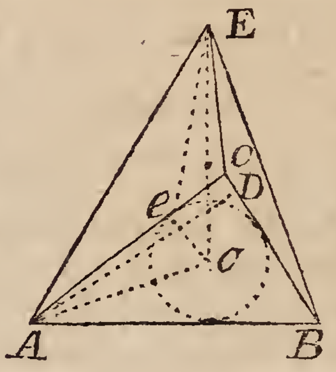
Having drawn the given ſide AB, and the lines AD, AC making the given angles BAD, DAC; in BA produced take AE to AB in the given ratio of CD to DB, that is, of 2 to 3; draw EC parallel to AD; laſtly draw CB, and it is done.



For, by ſim. $\triangle$s, $AB : AE :: BD : DC$.

V. QUESTION 140 *anſwer'd by Mr.* LOWE *the propoſer.*

Put $AB = b$, the ſine of the angle $ACD = s$, its coſine $= c$, $4103 = p$, $AC = a$, and $BC = e$; the radius $= 1$. As $1 : a :: s : sa = AD$; and $1 : a :: c : ca = CD$: but $ae + a + e = p$; hence $e = \dfrac{p-a}{a+1}$, and $\dfrac{p-a}{a-1} - ca = BD = \dfrac{p-a-ca^2-ca}{a+1}$: Put $1 + c = x$, then $\dfrac{p - xa - ca^2}{a+1} = BD$. Hence $\dfrac{c^2a^4 + 2xca^3 - 2pca^2 + xxaa - 2pxa + pp}{aa + 2a + 1} + ssaa = bb$. Which equation reduced gives $a = 75$; and thence $e = 53$.



For the pyramid's altitude. The radius of the inſcribed circle is 18·3315 inches $= r$. And $Ac = 57{\cdot}97468$ inches $= b$; $a =$ pyramid's height $= Ec$. Then $\sqrt{aa + rr} = Ee$ the leſſer hypothenuſe, and $\sqrt{aa+rr} \; 1 :: a : \dfrac{a}{\sqrt{aa+rr}} =$ the ſine of the greater angle of altitude. Then $7 : 6 :: \dfrac{a}{\sqrt{aa+rr}} : \dfrac{6a}{7\sqrt{aa+rr}} =$ the ſine of the leaſt angle of altitude; alſo $\dfrac{6a}{7\sqrt{aa+rr}} : a :: 1 : \frac{7}{6}\sqrt{aa+rr} = AE$ the greater hypothenuſe. And $aa + bb = \dfrac{49aa + 49rr}{36}$; which gives $a = 89{\cdot}6712$ the pyramid's height.

The height of the greateſt cylinder is found $= 29{\cdot}8904$, being 1-3d of the pyramid's height, the content 49·733 ale gallons; the diameter of the ſphere 30·5012, the content 52·687 ale gallons; the difference 2·953 ale gallons.

VI QUES-

VI. QUESTION 141 *anſwer'd by Mr.* Lovatt.

This queſtion may be found in Mr. Kerſey's Algebra, p. 299. We have given $aa + ae = 20$, $ee + ey = 30$, and $yy + ya = 40$; which will give $\sqrt{40 + \frac{1}{4}aa} - \frac{1}{2}a = \frac{70aa - 400 - a^4}{20a - aaa}$; and reduced is $a = 3{\cdot}051$, $e = 3{\cdot}526$, $y = 4{\cdot}98$.

* VII. QUESTION 142 *anſwer'd by Mr.* Rich. Lovatt.

The length 372 inches $= d$, bung diameter $= 252 = b$. If the caſk be the ſame ſhape as Parſons's, the head is the latus rectum; then $\sqrt{dd - bb} : b :: b : 141{\cdot}334 =$ the head per conics: finding an infinite number of ordinates 'twixt head and bung, will conſtitute the ſolidity $= 59780{\cdot}4$ wine gallons, and a mean of all thoſe ordinates will give an equal cylinder $= 217{\cdot}3072$ inches. A gallon of wine weighs $8{\cdot}29645$ pounds avoirdupois. Then $8{\cdot}296 \times 59780{\cdot}4 = 495965{\cdot}1593604$, the whole weight. A gallon of ſtout weighs $10{\cdot}25$ pounds avoird. $\times 5760 = 59040$, the weight of the liquor in Parſons's caſk. Then as the ſum of the weights is to the difference, ſo is the length of the balance to the difference of brachia $= 47{\cdot}2348$ feet. From Parſons's caſk the liquor flows $128{\cdot}8$ inches, equal bung diameter, in $34{\cdot}218$ thirds of time, Heidelberg caſk flows 252 inches in $47{\cdot}863$ thirds. Then put $d = 432000$, the thirds in 2 hours, $n = 34{\cdot}218$, $a =$ the drain of the bore in Parſons's caſk. And then $\frac{128{\cdot}8\,daa}{359{\cdot}05\,n} = 5760$; hence $a = 1{\cdot}127$ inch. And by the ſame way the bore is found $2{\cdot}78119$ inches in Heidelberg caſk. Mr. *Tho. Grant* makes the bores $3{\cdot}387$ and $1{\cdot}3518$ inches.

The

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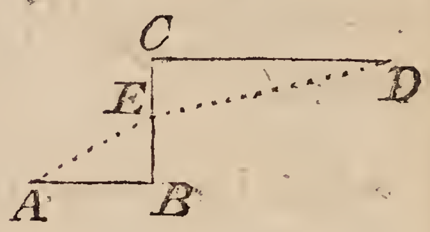
* VII. QUESTION 142.

The dimenſions of the apertures, as determined in the ſolution to this queſtion, may perhaps be pretty near the truth: but as for the mathematical certainty, there does not ſeem to be a poſſibility of it in the caſe.

* *The* PRIZE QUESTION *anſwer'd by Mr.* John Fearnſide.

Put $AB = c$, $CD = d$, $BC = b$, and $CE = b - x$. Then, per 47 Euc. 1. $AE = \sqrt{cc + xx}$; and $DE = \sqrt{dd + bb - 2bx + xx}$. Then, by the queſtion, $2 : 1 :: \sqrt{dd + bb - 2bx + xx} : \sqrt{\frac{dd + bb - 2bx + xx}{4}}$, and



$3 : 1 :: \sqrt{cc + xx} : \sqrt{\frac{cc + xx}{9}}$. Therefore $\sqrt{\frac{dd + bb - 2bx + xx}{4}} + \sqrt{\frac{cc + xx}{9}} = 0$: which thrown into fluxions, and reduced, $x = 18{\cdot}5723$, $CE = 43{\cdot}8776$, $AE = 44{\cdot}1015$, and $DE = 156{\cdot}286$; and the time in going the whole journey 92 hours 50 min. 30 ſeconds: Which agrees to the ingenious propoſer Mr. *Turner*, and ſeveral others.

On Candlemas-day laſt the lot of 10 diaries fell to Mr. *John Bulman* of Lewiſham, Kent.

Of

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* *The* PRIZE QUESTION.

This problem may be ſeen applied to various and very curious purpoſes in *Hayes*'s Fluxions.

Of the Eclipses in 1730.

In this year will happen five eclipses: three times will the moon's opake body interpose between the sun and earth, and hinder his rays from falling on the inhabitants: and twice will the earth come between, and prevent the sun's enlightening the moon.

1. Sun eclipsed the 7th day of january, between 6 and 7 at night, but invisible to us, because 'tis set.*

2. Moon eclipsed on friday the 23d of january, at 3 in the morning, visible.†

Computed by	Begin. h. m.	Midd.	End	Dur.	Dig.
By Astronom. Carol. Coventry	III 7	III c	IIII 53	I 46	2 39
Mr. Chattock, London	2 29	3 42	4 50	2 24	4 24
Mr. Leadbetter, London	2 37	3 33	4 30	1 52	2 53
Mr. J. Darley, Nottingham	3 2	3 56	4 50	1 48	2 45
Mr. J. Bulman, Lewisham in Kent	3 13	4 6	4 59	1 46	2 39
Mr. Wm. Brown, Bridgenorth	3 3	3 56	4 50	1 47	2 38
Mr. Williams, Middleton Story	2 31	3 44	4 51	2 25	4 40
Mr. Christ. Fairchild, Spalding	3 4	4 1	4 58	1 54	3 0
Mr. J. Newton, Melton Moberry	2 31	3 34	4 36	2 5	3 37

3. Sun

* This 1st Eclipse was observed in *Paragua*, in *South America*, by *F. Bon. Suarez*, thus:

	True time. h.	m.	s.	
Beginning	2	52	30	*p. merid.*
8 digits at	4	7	33	
0 dig. 30′ —	4	50	0	

The end was not observed because of clouds; it seems to have been at 4 h. 52 m. At about 4 h. 55 m. the disc of the sun was seen entire. The greatest obscuration seems to have been $8\frac{1}{3}$ digits.

† This 2d Eclipse was observed at *Lisbon*, by *P. J. Bapt. Carbone*, thus:

Temp.

3. Sun eclipsed on saturday july the 4th, at 3 quarters after 3 in the morning. The latter part of which, if the air proves favourable, will be visible. It rises eclipsed, near 5 digits, at 3 hours 36 min.*

Computed by		Begin.	Midd.	End.	Dur.	Dig.
Astronom. Carolina. Coventry		II 52	III 41	IV 32	I 40	5 49
Mr. Chattock (by Sci. Stet.) Cov.		2 36	3 25	4 17	1 41	6 5
Mr. Leadbetter, London		2 36	3 26	4 18	1 41	6 7
Mr. Jos. Smith,	London	over bef.	⊙ rise	4 30		4 30
	Constantinople		5 9	6 16		11 0
	Macao in Japan	1 14	2 50	4 10	2 56	11 0
Mr. C. Fairchild, Spalding		2 50	3 34	4 32	1 42	4 56
Mr. J. Newton, Melton Moberry		2 40	3 29	4 22	1 42	5 51
Mr. J. Bulman, Lewisham,		2 23	3 28	4 29	2 6	6 1

The fourth of the moon, july 19th, at 4 aftern. invisible.†

The fifth of the sun, december 28, at 10 in the morning, invisible, because of the moon's great parallel of latitude.

New

Temp. Ver. p. merid.

h.	m.	s.	
13	25	0	Incipit penumbra sensibilis.
13	40	0	Fit spissior.
13	58	0	Fit spississima.
14	3	45	Dubitatur de eclipsis initio.
14	4	32	Nunc certo incipere videtur.
16	4	0	Finis eclipsis.
			Duratio eclipsis 4h. 59m. 28s.
			Medium eclipsis 15h. 4m. 16s.
			Quantitas, dig. 3 min. 20, ad Boream.

* This 3d Eclipse was observed

1. At *Wirtemburg* by Mr. *J. F. Weidler:*

Dig. 4 a 4h. 50m. 15s. Temp. ver. ante merid.
Finis — 5 15 30

2. At *Padua* by Mr. *J. Polenus.*

Dig. 4 a 16h. 46m. 12s. Temp. ver.
Finis — 17 6 8

3. At *Peking* by *F. Ignat. Kegler* and *Andrew Pereyra* the end was observed at 2h. 27m. 10s.

‡ This 4th Eclipse was observed thus :

	Begin.	End
At *Chamxo* in *Nankin* by *P. Jac. Simonelli*	10h. 55m.	12h. 49m.
— *Cochinchina* by *P. Franc. de Lima* —	9 48	11 50

New Questions.

I. QUESTION 143, *by Mr.* Tho. Batterſbye.

There is a right-lined triangle, in which a circle is inſcribed; and in the corners of the triangle are placed three little circles, ſo drawn as to touch the adjacent ſides of the triangle, and the greater circle, whoſe diameters are 484, 441, and 400. It is required to find the ſides of the triangle, and the diameter of the greater circle?

II. QUESTION 144, *by Mr.* Will. Maſſey.

A painter of ſkill, and much fame in the town,
Had procur'd himſelf work for more hands than his own,
He employ'd an aſſiſtant, to help him in part;
A proficient in every branch of his art.
O'er a glaſs of good wine upon terms they debate,
And the bottle was drain'd while they ſtate and unſtate:
For as plenty of Bacchus's enlivening juice,
Does moſt commonly projects and whimſies produce;
So when that their ſpirits grew warm with the liquor,
Freſh maggots were ſtarted, and fancies flow'd quicker.
They were long in contriving what both ſides cou'd pleaſe,
And at length the propoſals agreed on were theſe:
For a ſingle year's ſervice the man ſhou'd be ty'd;
And for every day that he full was employ'd,
Seven ſhillings per day ſhou'd his wages be paid;
But for all ſuch as thoſe when he reſted or play'd,
He ſhou'd forfeit three ſhillings: The year was compleat,
Neither maſter nor man was in each other's debt.
Now, what time he neglected, fair artiſts, is ſought,
And how much for his maſter in painting he wrought?

III. QUESTION 145, *by Mr.* Rob. Fearnſide.

Two ſhips *A* and *B*, weſt and eaſt from each other,
Were bound to a port that they cou'd not diſcover;
To do which the ſhip *A* takes her way as below*; (*$8\frac{5}{14}$ *leag.*
Betwixt north and eaſt, but what point do not know,
Till ſhe found the port north (for diſtinction call *D*)
Of herſelf and the place where ſhe left the ſhip *B*;
Which ſoon as eſpy'd, the ſhip *B* anchor weigh'd,
And failed due eaſt as is here diſplay'd, (12·8 *leagues.*
But

But deſpairing to ſee the port *D*, furls her ſails,
As other ſhips uſe to do when nought avails;
While *A* ploughs the ocean but ſlowly along,
But by ſome chance or other the ſpace was unknown,
Tho' her courſe, or the point of the compaſs the ſame
That ſhe ſail'd from the very firſt place that ſhe came:
Till by obſervation *D B*, as before,
The contrary points of the compaſs they bore
Of ſhip *A*, who was juſt five leagues from the ſhore.
And ſince I have found that the ſpace in the ſea
Whence *A* firſt ſet ſail, and the anch'ring of *B*.
(If *D* be made center) includes a fourth part
Of the mariners compaſs; or if with leſs art,
To thoſe who ne'er ſail'd, I ſhou'd better explain
The diſtance, a right angle juſt doth contain.
Now, ladies, the diſtance betwixt the port *D*,
And where *A* did firſt ſail from, as alſo of *B*;
And likewiſe the courſe of ſhip *A* let be known?
And aught in the Indies pray claim as your own.

IV. QUESTION 146, *by Mr.* Tho. Grant.

Ye learned fair, to whoſe all-piercing minds
Abſtruſeſt things are known; be pleas'd to ſhow
A gen'ral method, that with equal eaſe
May the equation * under-written ſolve,
Or any other of the ſame degree.

$$* \; x^x = 123456789.$$

V. QUESTION 147, *by Mr.* Tho. Williams.

In thirty-one, the ninth of june,
Happens a ſmall eclipſe o'th' moon;
Which to define I don't intend,
When 'twill begin, middle, or end,
Et cætera: but leave ſuch matters
To hoghen moghen calculators;
And only here in ſhort to tell you,
What I have done, and you've to do:
For having drawn as ſhou'd be done,
The mundane ſhadow, and the moon,
When ſhe is moſt immers'd therein,
As likewiſe when it does begin;
And finding theſe three wou'd explain
The matter that I thought to gain;

I join'd their centers with lines that
Made a rectangle triangulate,
Whose base and perpendicular,
Three minutes made above fourscore;
Likewise hypothenuse and base
Sixteen above fivescore t'an ace.
Hence, you're to shew each sep'rate side,
How much the terrene shadow's wide;
How much the moon's diameter,
And how much dark of her'll appear?
But one thing more I must disclose,
Lest you shou'd miss, that is, if four's
Added to the perpendicular,
'Twill make the moon's diameter.

VI. QUESTION 148, *by Mr.* Tho. Sparrow.

Come, Athens sons, shew me how to find the place where
(Betwixt here and the moon) that an unactive sphere,
Depriv'd of all motion shall in equilibro depend;
By those two globes attraction, and neither descend;
And give an example (if you think it fit)
When the moon is the nearest the orb will admit.

VII. QUESTION 149, *by Mr.* Rich. Lovatt.

Assist, ye muses nine, grant me your aid
To speak in verse, for truly I'm afraid;
My tongue wants eloquence for to declare
How much of praise is due unto the fair.
If the sun's altitude be thirty-three,
On june the third, and the hour angle be
Equal co-latitude; from whence I pray,
Give me a theorem, with the hour o'th' day.

VIII. QUESTION 150, *by Mr.* John Turner.

There is a meadow in form of a parabola, the abscissa of which is equal to 40 chains, and the greatest ordinate (that which bounds the meadow) is 72 chains, from whence the latus rectum will be found 32·4 chains. It is required to inscribe such a parallelogram in this parabola, as that its area may be greater than the area of any other parallelogram that can possibly be inscribed in the said parabola, and to give the analytical investigation of the same?

IX. QUES-

IX. QUESTION 151, *by Mr.* Chr. Maſon.

In a fair vale where fruitful fields appear,
And Flora's beauties flouriſh round the year;
There dwells, and long has dwelt, an aged ſire,
Where the ſame race ſix cent'ries did expire.
There his own land with his own cattle tills;
No weight of wealth, nor poverty he feels;
The wiſeman's wiſh he makes his higheſt aim;
A frugal plenty ſtill ſupplies the ſame.
His youthful years in uſeful arts did ſpend,
T'improve his judgment, and inſtruct his friend;
That his gen'ration might him uſeful find,
And live to die, as the great God deſign'd.
Recluſe from balls, from maſquerades, and court,
Where vice triumphant, with her tools reſort;
Deſpis'd the town, where fops and cullies roam,
And with his choice ſedately ſtaid at home.
Now with delight as hoary years arrive,
He ſees his ſons with emulation ſtrive
Who ſhall his morals neareſt imitate,
Whilſt he with problems them does ſtimulate,
And they with expectation for his praiſes wait.
He well obſerves, and warily does praiſe,
Leſt he ſhou'd ſtrife, not emulation raiſe.
With winning ways he calmly does correct,
Leſt thro' reproof his council they reject:
As thus the ſire, —— ' My ſons, I you adviſe,
' Fair virtue chuſe, deluding vice deſpiſe;
' Let the great God with rev'rence be ador'd,
' Be art your ſport, and live in one accord.
' To what each genius by nature made,
' Be that his art, his calling, or his trade;
' And then with patience prudently purſue,
' Few years will gain what ages never knew.
' And now, fair youths, with vigour make't appear,
' Which of your brows the paper crown ſhall wear:
' Reſolve this * quere, which I here propoſe;
' Your pious mother's and my age it ſhows.

* $\left\{\begin{array}{l} aaae + aaeee = 3800000000 = b. \\ eeea + eeaaa = 4067442500 = c. \end{array}\right\}$ Quere *a* and *e*?

The

The PRIZE QUESTION.

Laſt Candlemas-eve, the eclipſe of the moon
Made her talk'd of much more than wou'd elſe have been
Her vulgar admirers all gueſs'd at her nature; (done;
By which it appear'd, they knew nought of the matter:
Some computed her age, but at four weeks juſt,
When a new one was made, 'cauſe the old one was loſt:
Others thought this a coſtly, and waſtable trade;
And urg'd that new ſtars from the old ones were made;
But this was retorted with ſquibs, and with jeers,
Can dotted old moons make ſhining new ſtars?
So whatever one ſaid was oppos'd by another,
Which was likely to make a moſt damnable pother:
When a glover ſtarts up, and thus ſpoke t'her honour,
And after this ſort, he commented upon her.
Good neighbours, the moon is a world I dare ſwear;
And let any preſume to deny't if they dare:
The great biſhop Wilkins hath prov'd what I ſaid;
Nay, I'd fetch you his book, if I thought you cou'd read:
Then ceaſe your dull whimſies, and ſtudy with me,
How to ſettle a trade betwixt they and we:
Shou'd we loſe Gibraltar and the port of Mahone,
Pray judge the advantage of a trade to the moon.
The noiſe was ſtreight huſh'd! a deep ſilence began!
For all gazing ſtood, and admired the man:
Such heads being at work, we need not to fear,
But we ſhall ſoon have ſhips ſailing up in the air;
And the way, without doubt, moſt eaſy be made;
And the world of the moon, Great Britain's chief trade.
But ſome few things I cou'd wiſh, were put in good light,
For informing our factors and merchants aright;
Which far harder may prove than their tare and their tret,
And if ignorant on't, they nothing may get;
But their profit and loſs, and terms us'd in books,
When ſcrew'd into metre, but aukwardly looks:
So for want of fit words for to gingle and chime,
I'll quere in proſe, and ceaſe my dull rhyme.

Suppoſe at the time above *A*, *B*, and *C* make a ſtock of 22650 hundred weight, and it's ſold at the moon for 2336193 *l.* 9 *s.* 7 *d.* $\frac{1}{6}$, being ſold at a hundred times more per ton than it coſt; and ſuppoſe the price of *A*'s ſtock in pounds be the ſquare root of the ſtock of *B*; and the ſtock of *A* and *B*, the ſquare root of the ſtock of C. Quere each man's ſtock and gain, and the weight of the goods at the moon; and becauſe if the ſame goods, at the ſame price, had been ſold at the globe of Jupiter, the amount had been 9108924 l. Quere the weight at his body alſo?

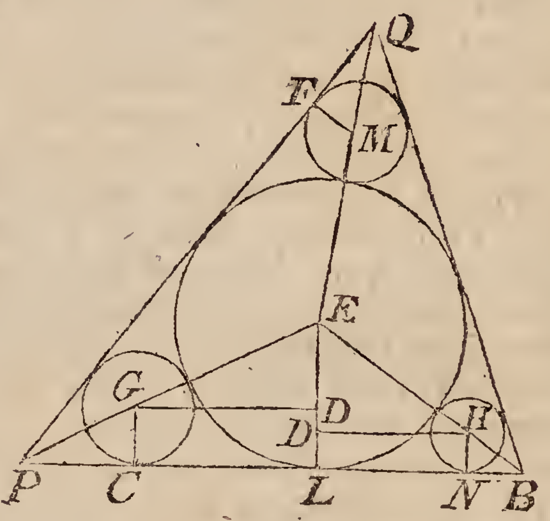
Queſtions

1731.

Questions answered.

I. QUESTION 143 *answer'd by Mr.* Rich. Lovet.

Given $\begin{cases} NH = 220'5 = dd, \\ GC = 242 = nn, \\ FM = 200 = bb, \\ EL = aa, \end{cases}$



Per 47 Eucl. 1, we have $a^4 + 2aadd + d^4 - a^4 + 2aadd - d^4 = 4aadd = HD^2$, and $\therefore 2ad = HD$.

Again $aa - dd : 2ad :: aa : \frac{2a^3d}{aa-dd} = BL$.

Hence $\frac{2a^3d}{aa-dd} + \frac{2a^3n}{aa-nn} = BP$, $\frac{2a^3d}{aa-dd} + \frac{2a^3b}{aa-bb} = BQ$, $\frac{2a^3n}{aa-nn} + \frac{2a^3b}{aa-bb} = PQ$.

Or $BP = \frac{2a^5d - 2a^3dn^2 + 2a^5n - 2a^3nd^2}{\overline{aa-dd} \times \overline{aa-nn}}$;

Suppose $\begin{cases} m = 2d + 2n, \\ k = 2n^2d + 2nd^2: \end{cases}$

And $PQ = \frac{2a^5b - 2a^3bn^2 + 2a^5n - 2a^3b^2n}{\overline{aa-nn} \times \overline{aa-bb}}$;

Suppose $\begin{cases} c = 2b + 2n, \\ p = 2bn^2 + 2nb^2. \end{cases}$

Hence $\frac{BP+PQ+QB-2PB}{2} \times \frac{BP+PQ+QB-2PQ}{2}$

$$= \frac{4a^6db}{\overline{aa-dd} \times \overline{aa-bb}}.$$

But

But $aa + nn : 1 :: aa - nn : \frac{aa - nn}{aa + nn} = s. \angle EGD$;

and, by that curious theorem 31 in Spherical Triangles explained by Ozanam, vol. II. p. 142) which holds good in all triangles, we have $\frac{a^4cm - aack - aamp + pk}{a^4 - 2aann + n^4}$ $: 1 :: 4dh : \overline{\frac{aa - nn}{aa + nn}}\Big|^2$;

Hence $a^4cm - 4a^4dh - aack - aamp - 8aanndh = 4n^4dh - kp$. Sub. $b = ck + mp + 8nndh$, and $l = cm - 4dh$;

Then $aa = \frac{b}{2l} + \sqrt{\frac{4n^4dh - kp}{l} + \frac{bb}{4ll}} = 661 = EL$.

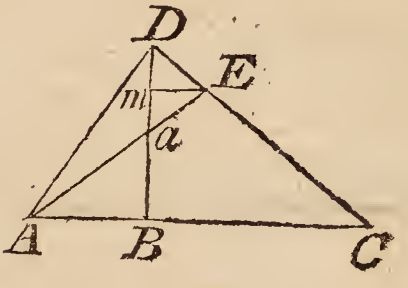
And the lines are $2aa = 1322$, $PB = 2407{\cdot}85$, $BQ = 2188{\cdot}48$, $PQ = 2304{\cdot}72$.

* II. QUESTION 144 *anſwer'd by Mr.* Geo. Anderſon.

Let $b = 365 =$ the number of days in a year, $a =$ the number of days wrought; then $b - a =$ the number of days play'd; therefore $7a = 3b - 3a$ per queſtion. Whence a will be found $= 109{\cdot}5$ days wrought; and $255{\cdot}5 =$ the days play'd.

III. QUESTION 145 *anſwer'd by Mr.* Geo. Anderſon.

Put $Aa = a$, $BC = b$, and $DA = d$. Draw mE parallel to AB, and call it x.



Per ſimilar $\triangle$s $x : d :: b : \frac{bd}{x} = CD$, and $x : d :: \frac{bd}{x} : \frac{bdd}{xx} = AC$;

Then by 47 E. 1, $\sqrt{\frac{b^2d^4 - b^2d^2x^2}{x^4}} = AD$.

Alſo

* II. QUESTION 144.

As $10 (= 7 + 3) : 365 :: \begin{cases} 7 : {\cdot}7 \times 365 = 255{\cdot}5, \\ 3 : {\cdot}3 \times 365 = 109{\cdot}5, \end{cases}$

Also $\frac{bdd - bxx}{xx} = AB$, $\therefore$ per similar $\triangle$s, $\frac{bdd - bxx}{xx}$

$$: a :: x : \frac{ax^3}{bdd - bxx} = Ea.$$

By 47 Eucl. 1, we have

$$\sqrt{\frac{aax^6 - 2baax^5 \begin{matrix} + bbaa \\ - bbdd \end{matrix} x^4 + 2bddaax^3 \begin{matrix} + 2bbd^4 \\ - 2bbddaa \end{matrix} x^2 \begin{matrix} - bbd^6 \\ + bbd^4aa \end{matrix}}{bbd^4 - 2bbddxx + bbx^4}}$$

$= AD.$

Which being made equal to the above value of it, and the equation reduced, we have

$$aax^{10} - 2baax^9 \left.\begin{matrix} + bbaa \\ - bbdd \end{matrix}\right\} x^8 + 2bddaax^7$$

$$\left.\begin{matrix} + bbdd \\ - bbddaa \\ + b^4dd \end{matrix}\right\} x^6 \left.\begin{matrix} - b^2d^6 \\ + b^2d^4a^2 \\ - 3b^4d^4 \end{matrix}\right\} x^4 + 3b^4d^4d^6x^2 = b^4d^8.$$

Or in numbers, $x^{10} - 25{\cdot}6x^9 + 105{\cdot}1932x^8 + 640x^7 + 4349{\cdot}031x^6 - 64906{\cdot}085x^4 + 18016295{\cdot}945649x^2 = 150135799{\cdot}54708$, &c.

Which solved, is $x = 4$ leagues.

Therefore $AD = 12$ leag. = dist. ship A from D,
$BD = 9{\cdot}6$ dist. ship B from D,
$BAa = 30^\circ\ 28'\ 53''$ the course of ship A.*

The proposer of the question, Mr. Fearnside, gives the course the ship took N.E. by N. $\frac{1}{4}$ 35′ 39″ N. but the answer above agrees exactly with him as to the scheme and method.

IV. QUES-

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* III. QUESTION 145.

To render this question and its solution plain, it may be remarked that, In the triangle ADC, right-angled at D, having drawn AE and the perpendicular DB, there are given $Aa = 8\frac{5}{14}$ $BC = 12{\cdot}8$, and $DE = 5$; to find the other parts.

* IV. QUESTION 146 *answer'd by Mr.* Tho. Grant.

There is given $x^x = 123456789 = a$. Quere x?

Let n be aſſum'd near the root x, $z =$ their difference, and $ln =$ the hyperbolic logarithm of n: Then $n \pm z = x$, and (per fluxions) its hyp. log. $= ln \pm \frac{z}{n} - \frac{z^2}{2n^2} \pm \frac{z^3}{3n^3} - \frac{z^4}{4n^4} \pm \frac{z^5}{5n^5}$, &c. this multiplied by $n \pm z$ gives $nln \pm z \pm zln + \frac{z^2}{2n} \mp \frac{z^3}{6n^2} + \frac{z^4}{12n^3} \mp \frac{z^5}{20n^4}$, &c. $= la =$ the hyperb. log. of a.

Put $s = 1 + ln$, $d =$ the difference between la and nln; then $sz \pm \frac{z^2}{2n} - \frac{z^3}{6n^2} \pm \frac{z^4}{12n^3} - \frac{z^5}{20n^4}$, &c. $= d$; which by inverting the ſeries becomes $z = \frac{1}{s}d \mp \frac{1}{2ns^3}d^2 + \frac{3+s}{6n^2s^5}d^3 \mp \frac{15+10s+2s^2}{24n^3s^7}d^4 + \frac{105+165s+60s^2+6s^3}{120n^4s^9}d^5$, &c. this wrought in numbers gives $n \pm z = x = 8{:}6400268$.

N. B. The above method will find x to any degree of accuracy by only aſſuming n nearly $=$ to x, and even without that if the logarithm of a and n be made to a ſufficient number of places.

V. QUES-

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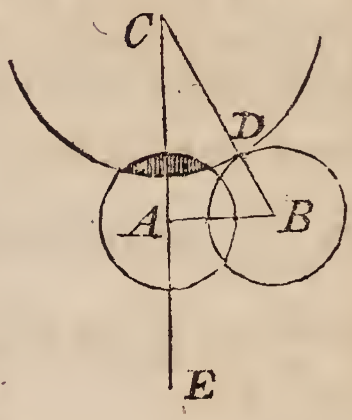
* IV. QUESTION 146.

Though the above be a very complete and maſterly ſolution, the method of trial-and-error would ſooner approximate to the value of the root.

* V. QUESTION 147 *anſwer'd by Mr.* W. Grimmet.

Let $a = AC$ the baſe, $b = AC + AB$ the ſum of the baſe and perpendicular, $c = AC + BC$ the ſum of the baſe and hypothenuſe: Then $b - a =$ the perpendicular; and, per 47 Eucl. 1, $\sqrt{2aa - 2ba + bb} = CB$ the hypothenuſe. Therefore $\sqrt{2aa - 2ba + bb} + a = c$: which equation ſolved, a will be found $=$ 54·4985 the baſe, and perpendicular $=$ 28·5015, to which add 4 gives the moon's diameter $=$ 32·5015; and if from the hypothenuſe $=$ 61·5015, be ſubtracted the moon's ſemidiameter, it leaves CD $=$ 45·2508 $=$ ſemidiameter of the earth's ſhadow; alſo from the hypothenuſe ſubtract the baſe, remains the opaque part of the moon $=$ 7·0028 $=$ 2 digits $35'\ 7''$.



VI. QUES-

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* V QUESTION 147.

This queſtion is the ſame as, *In a right-angled triangle, having given the two ſums of the baſe and hypothenuſe, and baſe and perpendicular; to determine the triangle.* Of which this is the

Conſtruction.

The difference between the two given ſums will evidently be equal to the difference between the hypothenuſe and the perpendicular: Take EA equal to this difference, and $EAC =$ a mean proportional between $2EA$ and the greater of the above two ſums; and AC will be the baſe of the triangle. Then the hypothenuſe and perpendicular are eaſily found by ſubtraction.

Demonſtration.

Since $CE^2 = \overline{CA + AE}|^2 = CA^2 + 2CA \times AE + AE^2$ by Eucl II. 4,

And $AE = CB - BA$ by the conſtruction,

Alſo $AE^2 = CB^2 - 2CB \times BA + BA^2$ by Eucl. II. 7,

We have $CE^2 = CA^2 + 2CA \times CB - 2CA \times AB + CB^2 - 2CB \times BA + BA^2$;

Again $CB^2 = CA^2 + BA^2$ by Eucl. I. 47,

Therefore $CE^2 = 2CB^2 + 2CB \times CA - 2CB \times BA - 2CA \times AB$
$= \overline{CB + CA} \times \overline{2CB - 2BA}$ (by Eucl. II. 1.)
$= \overline{CB + CA} \times 2AE.$ Q.E.D.

* VI. QUESTION 148 *anſwer'd by Mr.* John Fearnſide.

Two bodies gravitating towards each other, the diſtances of the common center of attraction, are directly as the quantities of matter in the bodies: Whence the quantity of matter in the earth being, according to Sir Iſaac Newton, to that of the moon, as 39·778 to 1. And the mean diſtance of the earth and moon = 1271018757 Engliſh feet, the diſtance required from the earth 215882 miles, and from the moon 59018 miles.

The moon is at her neareſt diſtance from the earth, when ſhe tranſits her perigæon at the moment of her being in oppoſition to the ſun; and the earth in aphelium; which happens very nearly, (viz.)

		da.	h.	′	″
The moon in perig.	1730, june	18	19	36	31
Full moon	— — —	18	21	3	31
Earth in aphelium	— —	18	23	51	0

Mr. W. Grimmet, who has anſwer'd this queſtion, obſerves that there may be different anſwers to the queſtion, according to the authors made uſe of for the diſtances and magnitudes. Some few of the anſwers follow:

	From earth.	From moon.		Eng. miles.	
Mr. *Beacham*	218985	5688	Mr. *Maſon*	228302	5779
Mr. *Grimmet*	204395	7669	Mr. *Grant*	1090685659 and	
Mr. *Bulman*	202143	4166		27414940 Paris feet.	
Mr. *Hawkſworth*	231059	4955			

VII. QUES-

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* VI. QUESTION 148.

The above anſwers to this queſtion are all wrong. For, the gravitation towards any body being as its quantity of matter directly and ſquare of its diſtance inverſly; if e to m denote the proportion of the quantity of matter in the earth to that in the moon, d the diſtance of their centers, and x and z the reſpective diſtances, from their centers, of a body placed between them; then the gravitation towards the earth will be as $\frac{e}{x^2}$, and towards the moon as $\frac{m}{z^2}$: that the body be at reſt between them then, or gravitate equally towards them, we muſt make $\frac{e}{x^2} = \frac{m}{z^2}$, and hence $\sqrt{e} : \sqrt{m} :: x : z$; that is, the diſtances from them muſt be as the roots of the maſſes, which in the preſent caſe are nearly as $6\frac{1}{3}$ to 1.

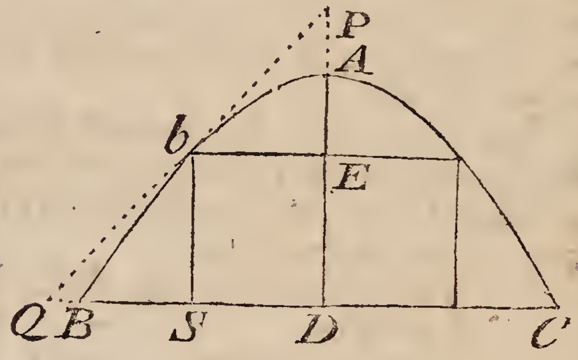
$$\text{Hence } \sqrt{e} + \sqrt{m} : d\ (= x + z) :: \begin{cases} \sqrt{e} : \dfrac{d\sqrt{e}}{\sqrt{e}+\sqrt{m}} = x, \\ \sqrt{m} : \dfrac{d\sqrt{m}}{\sqrt{e}+\sqrt{m}} = z. \end{cases}$$

* VII. QUESTION 149 *anſwer'd by Capt.* Wm. Scarth.

The latitude 26° 33′ N. the hour 4 h. 13′ 48″.

† VIII. QUESTION 150 *anſwer'd by Mr.* Geo. Anderſon.

Put $AD = b$, $BD = d$, the latus rectum $= l$, and $x = bE$? Per conics, $l : d + x ::$ $d - x : \frac{dd - xx}{l} = bS$,



By 35 Eucl. 1, $\frac{2ddx - 2x^3}{l}$ = area of the parallel.

This in fluxions,

$$\frac{2dd\dot{x} - 6x^2\dot{x}}{l} = 0,$$

$$dd = 3xx,$$

Hence $x = d\sqrt{\frac{1}{3}} = 20{\cdot}7846$; and $\frac{2ddx - 2x^3}{l} = 1108{\cdot}512$, &c. ſquare chains $=$ 110 a. 3 r. 16 p.

IX. QUES-

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* VII. QUESTION 149.

Here are given $Z\odot$ the co-altitude $= 57°$ (ſee the ſpherical triangle in page 227) $P\odot$ the co-declination $= 66° \; 31'$, and $ZP =$ the angle P.

Put $a =$ s. altitude $=$ coſ. $Z\odot$,
$d =$ s. declination $=$ coſ. $P\odot$,
$c =$ its coſ. $=$ s. $P\odot$,
and $z =$ coſ. PZ or $\angle P$.

Then, per ſpherics $\frac{a - dz}{c\sqrt{1 - z^2}} = z$;

Hence $cc z^4 - cc zz + dd zz - 2adz = -aa$; the root of which equation will anſwer the queſtion.

† VIII. QUESTION 150.

If to the point b there be drawn a tangent meeting the abſciſſa and ordinate, produced, in P and Q: Then, in all curves that are concave towards their axes, it is $QS = SD$, and therefore $DE = EP$ by ſimilar triangles; but, by the nature of the parabola, AE is $= \frac{1}{2}EP$; therefore $AE = \frac{1}{2}ED$ or $= \frac{1}{3}AD$; and conſequently the height of the parallelogram $ED = \frac{2}{3}AD$. Alſo, ſince the ordinates of a parabola are as the ſquare roots of their abſciſſas, and the abſciſſas being as 3 to 1, therefore the ordinates are as $\sqrt{3}$ to 1.

So that $AD : AE :: 3 : 1$,
and $BD : bE :: \sqrt{3} : 1$.

* IX. QUESTION 151 *anſwer'd.*

$$\left.\begin{array}{l} a = 85{\cdot}379 \\ e = 79{\cdot}899 \end{array}\right\} \text{their ages.}$$

The PRIZE QUESTION *anſwer'd.*

This queſtion may admit of ſome differences in the anſwer as the proportions vary in authors. I ſhall therefore firſt give you the propoſer Mr. *Tho. Pointin*'s anſwer.

The diſtance of the earth and ☉ 80015040 miles.
From the center of ⊖ to ☽ — 236350
From center ☉ to ☽ ſurface — 80251390
The weight of a body at the ☉ and ☽ as 1 to ·516; the force of the ⊖ at ☽ ·516 — ·000284 : = ·515716 × 22650 = 11680·96 the weight at the ☽ ; by which the prime coſt is 2*l.* per hundred: for ·515716 × 100 × 22650 = 1168096·74) 2336193·48 (2. Let $2a$ = *A*'s caſh, $4aa$ = *B*'s, and $16a^4 + 8a^3 + aa$ = *C*'s ſtock. Therefore $16a^4 + 8a^3 + 5aa + a$ = ſum. *A* = 6 price 12 lib. *B* 150, *C* 2250, and total ſtock = 22650. The total gain 2290893, of which *A*'s gain = 606·8592 lib. *B*'s = 14564·6208, *C*'s = 2275722: the weight at the earth and Jupiter as 1 to 2·0108. So the weight will be 4554462 = 2033 tun 4 cwt. 94 lb. Mr. *Grimmet*, Mr. *Sidebottom*, Mr. *Bullman*, Mr. *Fearnſide*, Mr. *Pilgrim*, and ſome others, make the weight at the moon 567 tuns, at Jupiter 2210 tuns. Mr. *Richards*, Mr. *Fairchild*, Mr.

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* IX QUESTION 151.

Of the two given equations $\left\{\begin{array}{l} a^3e + a^2e^3 = b \\ a^3e^2 + ae^3 = c \end{array}\right\}$, the latter being multiplied by a, and the former taken from the product, there remains $e^2a^4 - ea^3 = ca - b$; hence $e = \dfrac{a \pm \sqrt{a^2 + 4ac - 4b}}{2a^2}$: this being ſubſtituted in one of the original equations, there will reſult an equation with only one letter in it, and which from it may be found.

Otherwiſe.

Take two near values of a and e, as 85 and 80, and call the differences x and z; then $a = 85 + x$, and $e = 80 - z$: ſubſtitute theſe in the two original equations, neglecting all the terms which riſe to above two dimenſions, and there will reſult two quadratic equations, from which x and z may be found.

Mr. *Hale*, Mr. *Lowe*, Mr. *Mason*, Mr. *Grant*, and some others, 386 tun at ☽, and 15071 at Jupiter; several of whom have wrought this question very curiously, and in an algebraic method, but my room will not permit inserting them.

The prize of 10 diaries fell to the lot of Mr. *J. Pilgrim.*

Of the Eclipses in 1731.

To the inhabitants of this terraqueous globe this year will happen four eclipses: Twice will the moon's opake body interpose between the sun and us, and hinder part of his rays falling on the earth: And twice will the earth come between and hinder the sun's giving the moon her borrow'd light.

1. Moon eclipsed on Wednesday the 9th of june, at 3 quarters past 1 in the morning, about 2 digits north.

Computed by	Begin h. m	Midd.	End	Dur.	Dig.
By Astronom. Carol. Coventry	0 59	1 43	II 27	1 27	2 0
Mr. Chattock, London —	1 1	1 54	2 46	1 44	2 44
Mr. Leadbetter, London —	1 12	1 54	2 37	1 25	1 52
Mr. Turner — — —	0 59	1 45	2 31	1 32	2 2
Mr. Pilgrim — — —	1 4	1 49	2 35	1 31	1 59
Mr. Wm. Brown, Bridgenorth	0 55	1 39	2 22	1 27	2 0
Mr. J. Bulman, Lewisham in Kent	1 5	1 49	2 33	1 28	2 2
Mr. J. Fearnside — — —	0 34	1 19	2 4	1 30	2 4
Mr. Oats, Falmouth — —	0 36	1 20	2 4	1 28	2 9
Mr. J. Newton, Melton Moberry	1 3	1 50	2 37	1 33	2 15

2. Sun eclipsed the 23d of june, at 1 min. past 6 in the morning, but invisible, because the moon having south latitude, her parallax depresses her too much in our northern latitude.

3. Moon eclipsed the 2d of December, at 36 min. past 11 in the morning, and consequently invisible to us.

4. Sun eclipsed the 17th of December, at 57 min. past 12 at night, and therefore invisible to us.

New Questions.

I. QUESTION 151, *by Mr.* Tho. Williams.

Far in the weſt, I know not where,
But ſomewhere on this earthly ſphere,
A lofty pillar ſtands erected,
From the top of which a ball projected,
With a direction thirty-one
Degrees above the horizon,
Did, in nine ſeconds ten thirds ſpace,
Fall juſt two thouſand feet from its baſe.
Artiſts, this pillar's height explain
Above the horizontal plain.

II. QUESTION 152, *by Mr.* Geo. Anderſon.

Mr. Euclid Speidell, in his Geometrical Extractions, p. 59, ſays, If upon *C*, one end of the baſe *CA*, of the triangle *ABC*, you raiſe a perpendicular *CD*, equal to the perpendicular *BP*, let fall from *B* to *CA*, and join *DA*; that the right line *CE* biſecting the angle *ACD*, being produced, ſhall cut *DA* in ſuch a point *F* through which, if the right line *GH* be drawn parallel to the baſe *CA*, the part *GH* intercepted between the two ſides *BC* and *BA*, ſhall be the ſide of the ſquare made in the aforeſaid triangle.

Quere, The geometrical demonſtration?

III. QUESTION 154, *by Mr.* John Turner.

To Newton's genius, and immortal name,
And thoſe whoſe works in the records of fame
Like his will ever ſtand, what praiſe we owe;
Since 'tis from their diſcoveries we know
The various changes of the wand'ring moon,
And whence proceed th' eclipſes of the ſun;
What force the planets in their orbs retain,
Which move ſo ſwiftly thro' th' etherial plain;
What makes the ſea retreat, and what advance,
Varieties too regular for chance;
How vapours hanging on the lofty hills,
In breezes ſigh, or weep in warbling rills;
Whence infant winds their tender pinions try,
And tornado's bluſter in the ſky,
With ſome rais'd higher firſt in ſecret ſtreams,
Owe the reflected points of bounding beams;

Others,

Others, whofe parts a flight contexture fhow,
Sink hov'ring thro' the air in fleecy fnow;
And others laid in trains, that kindled fly,
In harmlefs fire by night, about the fky.
May we their bright examples emulate,
And mathematic knowledge propagate;
To anfwer which intent, ye fons of art,
Refolve the queftions which I here impart.

Let a ftone be whirl'd round in a fling, whofe length is equal to 33 inches, performing each revolution in the time of two thirds of one fecond. Required the ratio of the centrifugal force to the weight of the ftone? That is, the ratio of the tenfion of the ftring whirled round in this manner, to the tenfion arifing from the force of the fame weight hanging freely, and without motion?

IV. QUESTION 155, *by the fame.*

Suppofe the earth's radius = 6982000 yards, and that there is a mountain upon its fuperficies of fuch an height, that a clock when on the earth's furface, fhall point out equal time; but when carried to the top of the mountain, fhall be fo retarded as to err 2 minutes every day. 'Tis required to give that mountain's elevation.

V. QUESTION 156, *by Mr.* William Grimell.

Required the greateft parallelogram that can be infcribed in an ellipfis, whofe tranfverfe is 10, and conjugate 8: And fuppofing the ellipfis to revolve upon its tranfverfe axis, Required alfo the greateft cylinder that can be infcribed in the fpheroid that's generated by the revolving ellipfis? And to fhew the analytical inveftigation of the fame?

VI. QUESTION 157, *by Mr.* Chrift. Hale.

Unto a pleafant bower I took my way,
One evening late, it was the ninth of May;
Viewing the heav'ns, the works of mighty Jove,
Each glitt'ring ftar, in order as they move:
When one amongft the reft I did efpy;
Its rays of light came pointing to my eye.
Its name and latitude I fain would know;
From what is given here below.

The latitude of the place 29° 22′. The altitude is equal to the hour from noon, and equal to the azimuth.

VII. QUES-

VII. QUESTION 158 *by Mr.* John Fearnſide.

A garden lies on Ebor's fertile plains,
Where with magnificence fair Flora reigns:
She decks the flowers with moſt auſpicious hue,
The roſe vermilion, violet with blue.
Three lofty walls ſurround the beauteous place,
A curious ſtatue each of which does grace:
Erect they ſtand, and view th' adjacent plain,
Admir'd and ſeen by every neighb'ring ſwain.
Bacchus on this, on that Apollo ſtands;
Hermes (the meſſenger of Jove's commands)
Upon the third is plac'd, whoſe length, in feet,
Is known three hundred ſixty-three compleat.
With artful fancy, walks are form'd therein,
And various windings beautify the ſcene.
Three walks from the three effigies are made,
Where ſtately cedars yield a pleaſant ſhade;
The zephyrs revel in the ſportive boughs,
And kindly Sol's meridian heat ſubdues.
The walk from Hermes was to Bacchus known,
In feet and parts, as in the margin's ſhewn: (216·4074
And from Apollo to the other two
Is alſo given, as may be ſeen below.
Obſerve the walk between the unknown walls
At angles right, to one exactly falls, (* 55°
Which wall ſubtends an angle given, * from whence
The garden's area, and the walks true lengths,
Ladies, to whom our annual praiſe is due,
Vouchſafe to tell? For nothing's hid from you.

From Apollo to { Bacchus 192·1306 feet,
Hermes 209·694.

VIII. QUESTION 159, *by the ſame.*

What time of the day is the hotteſt at York on the 8th of June, ſuppoſing it to be as the ſine of the ſun's altitude, and the time of his continuance above the horizon?

IX. QUESTION 160, *by Mr.* Chr. Maſon.

In verdant meads, where I laſt ſpring ſurvey'd,
The flowing ſtreams did o'er the banks invade,
And forc'd me thence new methods to contrive:
So cowards fly, when ſeeming dangers drive.

I view'd

I view'd ſome marks where on dry ground I ſtood,
And then deſpis'd the proud inſulting flood.
From north to ſouth I'd chains juſt twenty-three,
Then weſt two marks I in one line did ſee.
Unto the firſt I could no meaſure take;
But 'tween the two I 40 chains did make.
Then to my northern ſtation I apply'd,
Where the two weſtern marks I plain deſcry'd:
Thrice ten degrees the angle made from thence,
By which you now may find this conſequence:
And in your next the diſtances define,
From thoſe two marks to th' ends of the firſt line.

X. QUESTION 161, *by Mr.* Tho. Pointin.

In th' Atlantic ocean an iſland is found,
Neither oblong nor ſquare, but perfectly round;
In the center of which a tower's erected,
From whence with much eaſe their foes are detected:
For if Neptune but ſmile, and the ſky be ſerene,
Four leagues * from the ſhore is the horizon ſeen,
We being at anchor, o'er the top o'th' maſt,
From the top o'th' tower a line being paſt,
Did bound the utmoſt ſtretch of ſight at laſt.
From thence we ſet ſail, and I'll tell you in ſhort,
The diſtance † we ran, to arrive at our port:
And alſo our courſe ‡ as corrected at noon,
Perform'd with great care by the height of the ſun:
Which, to my ſurprize, neither higher nor lower,
Was cut in two halves by the fore-mention'd tower.
The height of our maſt from the water's here ſhown,
And whatever elſe is moſt fit to be known §;
Which being ſuppos'd, what I want to be found,
Is the tower's juſt height, and land's compaſs round.
Beſides, when you're got in this figuring ſtrain,
Let's know the ſquare miles the whole doth contain.

* Note $69\frac{1}{2}$ *miles to a degree, three of which are a league.*

† *Our diſtance $\frac{2}{5}$ of a degree.*

‡ *Our courſe N. by E. 2° 45′ E. or 14° from N. to E.*

§ *The height of the maſt from the water 45 feet. Lat. 64° 20′ N. of the tower 63° 56′. The ſhip's diſtance from the ſhore is 1·263244 leagues.*

XI. QUESTION 162, *by Mr.* C. Maſon.

It is required to find two ſuch numbers, viz. A and B, that the ſum of the aliquot parts in A may be equal to $\frac{2}{3}$ of B, and the ſum of the aliquot parts in B equal to $\frac{3}{4}$ of A.

The

The PRIZE QUESTION, *by Mr.* Pointin.

From noiſy courts, and from the jangling bar,
Where lawyers tongues proclaim litigious war,
My friend withdraws, to his paternal ſeat;
A golden mean betwixt too ſmall, too great:
Where nature's wants ſtill meet a full ſupply,
With ample room for chriſtian charity:
For great eſtates but foſter up and feed
Thoſe vices which their own exceſſes breed.
Here Strephon liv'd in plenty, free from cares,
And bleſt contentment crown the circling years:
Vice here no favour found; 'twas virtue's court,
Where good and wiſe did ev'ry day reſort.
A foe to ignorance, a friend to truth,
A prop to age, a ſtar to wand'ring youth:
To th' fatherleſs, a gracious father was,
And ne'er forſook the mournful widow's cauſe.
A friend to all; for all by him were fed,
The rich with wiſdom, and the poor with bread.
Heav'n markt the man, from peaceful realms above,
Saw all his acts ſpring from the ſource of love,
To that great God, from whoſe refulgent throne
Whate'er of good we have, is ſhower'd down,
A faithful ſteward of his ſtock in truſt,
And to reward him heaven thought it juſt,
To all the good he had beſtow'd before,
To add yet one, one precious bleſſing more;
A bleſſing, which to mortals here below
Is ſeldom ſent, and none but fav'rites know,
A virtuous wife! To whoſe capacious mind
Both wit and beauty friendly nature join'd:
And as their years, ſo did their loves increaſe;
They liv'd contented, and they dy'd in peace.
Full well they knew, death but remov'd their ſeat,
Did not extinguiſh life, but change its ſtate;
Where is diſplay'd (O raviſhing ſurprize!)
Rich ſcenes of bliſs, and glory in the ſkies:
Two ſons, their virtue ſhare, which at one birth
Their pious mother with ſmall pain brought forth.
His lands he gave, by good advice in law,
To both ſo ſure, that it admits no flaw.
The caſh and goods your judgment muſt decide;
For ſo by will it's plainly ſpecify'd.
By what below is in few words declar'd,
The way you'll find by which it muſt be ſhar'd.

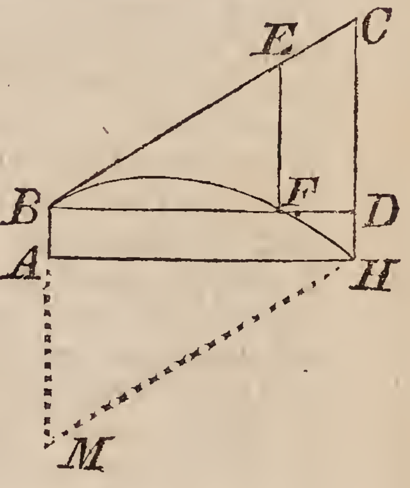
Call the eldeſt b, the youngeſt c: Then let $b+c=a$, then $c+\frac{a}{5}=b$ per father's will: D hath a yearly income or annuity that will fall to him ſeven years hence, and thence to continue ſeven years; which ſold at 6 per cent. $= \sqrt{ab}$, and the rent $= \sqrt[3]{ca}$. Quere a?

1732.

Queſtions anſwered.

I. QUESTION 151 *anſwer'd by Mr.* Rob. Fearnſide.

In the ſame time the ball deſcribes BE, another body let fall from E wou'd fall the ſpace EF, and conſequently in 9″ 10‴ time, when the ball is at H, an heavy body will deſcribe $CH = 1351{\cdot}4$ feet. Then as coſine 31° : $BD = 2000$ feet : : ſine 31° : $CD = 1201{\cdot}7$ feet; conſequently the pillar's height $= CH - CD = 149{\cdot}72$ feet $= AB$.



The ſame anſwer'd by Mr. Wm. Grimmett.

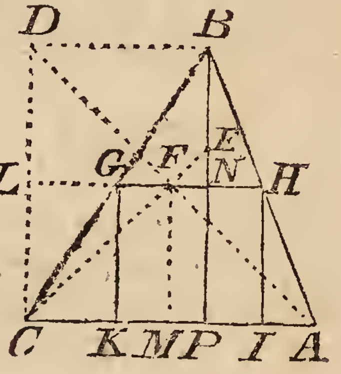
Let BA repreſent the pillar, AH the diſtance the ball falls from the baſe of the pillar equal to 2000 feet. Let CH be perpendicular to AH; BC the line in which the projectile is directed, in which it would move equal ſpaces in equal times, were it not deflected downwards by the force of gravity. 'Tis known all projectiles will (rejecting the reſiſtance of the medium) deſcribe parabolas: therefore BC is the tangent of that parabola, BD is parallel to AH the horizon: draw MH parallel and equal to BC: conſequently MH is an ordinate to the diameter BM. Then in the right-angled triangle BDC there is ſufficient given to find the ſides. And ſince the velocities of all projectiles in the ſeveral points

points of the curve, are as the lengths of the tangents to the parabola in those points, intercepted between any two diameters; therefore $BC = 2333.33$ divided by $9\frac{1}{6}$ (= number of seconds the ball was in motion) gives 254.54 the velocity in a second; and the square of the velocity divided by $16\frac{1}{12}$ feet, the space a body describes in a second by gravity, gives the parameter to the diameter BA. That is (per conics) the rectangle under the intercepted part of the diameter taken from its origin B towards A, and the parameter, is = the square of its correspondent semiordinate: whence the parameter is $= 4028.43$; and the square of MH divided by the parameter, gives $BM = 1351.5$. But $BM - AM = BA = 149.5$ the height of the pillar.

* II. QUESTION 152 *answer'd.*

Produce HG to L, and draw Fm and GK parallel to PB.

$\left.\begin{array}{l}(1)\ BP : BN :: CP : GN \\ (2)\ BP : BN :: PA : NH\end{array}\right\}$ per figure.



Per 11.5 Euc. (3) $CP : GN :: PA : NH$.
Per altern. (4) $CP : PA :: GN : NH$.
Per comp. (5) $CA : PA :: GH : NH$.
Per altern. (6) $CA : GH :: PA : NH$.
Per steps 2.6. (7) $BP : BN :: CA : GH$.
But the $\angle MCF$ per hypothesis is $\frac{1}{2}$ a right angle, and CMF is a right angle, and consequently CEM is $\frac{1}{2}$ a right angle, and therefore CM or $LF = FM = GK$. Moreover $DC = BP$ per hypothesis, and $DL = BN$ per construction. Therefore
Per. step 7. (8) $DC : DL :: CA : GH$.
But per fig. (9) $DC : DL :: CA : LF$.
Then per 11 E. 5. } (10) $CA : GH :: CA : LF$.
Therefore $GH = LF = GK$. *Q.E.D.* *Answer'd*

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* II. QUESTION 152.

This construction may be otherwise demonstrated thus:

As DC or $BP : CA :: DF : FA$ (Eucl. VI. 3) $:: DL : LC$ or GK (Eucl. VI. 2), but $BP : CA :: BN$ or $DL : GH$; $\therefore GK = GH$.

Why the proposer of the question calls *Speidell* by the name of *Euclid*, I know not. His name was *John*, as appears by the book, which was published in the year 1617.

Anſwer'd by Mr. Will. Grimmett.

The geometrical demonſtration of this problem may be eaſily ſeen from the propoſer's own ſcheme, without any previous conſtruction, (viz.) Since there cannot be but one ſquare inſcribed in that poſition, and that KC is equal to KF each ſubtending an angle of 45° (per prob.); therefore if we prove that KF is $= GH$ univerſally, it is demonſtrated; for KC is equal to GH (which is ſuppoſed to be a ſide of a ſquare.)

Demonſtration.

From 37 Euc. 1, the triangles DCB and DAB are equal; and if an infinite number of right lines as KH be drawn parallel to the common baſe DB, the parts of thoſe lines which are intercepted by the reſpective ſides of the triangles, will alſo be equal, that is $KG = FH$; which is Cavalerius's method of proving the triangles to be equal (which is the method of indiviſibles;) therefore if to both be added or ſubtracted (as the caſe requires) GF, $KF = GH$. *Q. E. D.*

III. QUESTION 154 *anſwered by the propoſer.*

As 113 : 355 :: 66 : 207·35 inches, the arch deſcribed in $\frac{2}{3}$ of 1″; and 207·35 ſquared and divided by 66, the double length of the ſling, is $=$ 651·03 the centrifugal force. But the deſcent of a heavy body in $\frac{2}{3}$ of 1″ is $=$ 86·208 inches: whence the centrifugal force is to the force of gravity as 651·4 to 85·7 or as 7·6 to 1.

The ſame anſwer'd by Mr. John Ommanney.

The ſtone, if let fall out of the ſling when at reſt, by the force of gravity would deſcend $85\frac{3}{4}$ inches; which call b. Now let F be the force of the ſtone or tenſion of the ſtring when at reſt; and E that when in motion. The lengths gone over are always proportional to the force impreſs'd. Therefore $F : E :: b : \frac{Eb}{F}$ the ſpace deſcended through with the force E in the ſame time. Let $c =$ the circumference of the ſling $=$ 207·344, and $d =$ diameter $=$ 66; then, by Sir Iſaac Newton, $\frac{cc}{d} = \frac{Eb}{F}$. Whence $F : E :: db : cc$. That is as 5659·5 to 42991·9, or as 1 to 7·596. *Q. E. I.*

IV. QUES-

* IV. QUESTION 155 *anſwer'd.*

The number of oſcillations in each place being equal, will be as the time in one place to the time in the other, viz. as 1440 to 1442. Let $n =$ earth's radius, and $a =$ radius and the height of the mountain together; the force of gravity being inverſly as the ſquare of the diſtance from the center, we ſhall have $1442n = 1440a$, and $\frac{1442n}{1440} = 6991698 = a$; from which ſubtracting the radius of the earth $= 6982000$, remains the mountain's height $= 9698$ yards $= 5\frac{1}{2}$ miles 18 yards.

Anſwer'd.

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* IV. QUESTION 155.

Univerſally, the lengths of pendulums being directly as the force of gravity drawn into the ſquares of the times of vibration, and the pendulum being of the ſame length in both caſes, we ſhall have $ft^2 = FT^2$, putting f and t for the force of gravity and time of vibration at the earth's ſurface, and F and T for the ſame at the top of the hill. But the force of gravity is inverſly as the ſquare of the diſtance from the earth's center; that is f is as $\frac{1}{r^2}$, and F as $\frac{1}{\overline{r+x}|^2}$, putting r for the earth's radius, and x for the height of the hill; then the above equation becomes $\frac{t^2}{r^2} = \frac{T^2}{\overline{r+x}|^2}$, or $\frac{t}{r} = \frac{T}{r+x}$. Again the time of a vibration being inverſly as the number of vibrations in a given time, and the number of vibrations being as 1440 to 1438; the ſame equation will become $\frac{1}{1440r} = \frac{1}{1438 \times \overline{r+x}}$: Hence $x = \frac{2r}{1438} = \frac{r}{719} = 9710{\cdot}7$ yards = the height of the mountain required.

Corollary.

Hence it appears in general, that if l be the time loſt in the time t; then 24 hrs. $- l : l :: r : x$; or, becauſe 24 hours $- l$ is nearly $=$ 24 hrs. it will be nearly as 24 hrs $: l :: r : x$; that is, the whole time is to the time loſt, as the radius of the earth to the height of the hill.

Anſwer'd by Mr. Geo. Anderſon.

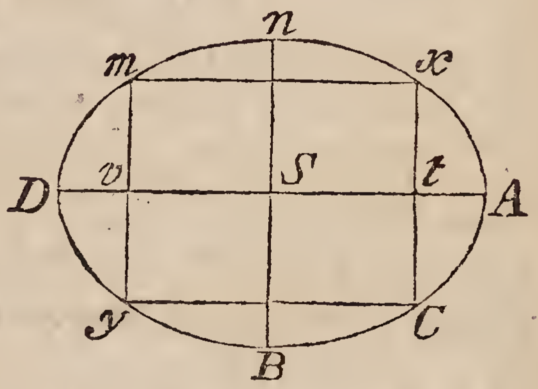
The length of a pendulum vibrating ſeconds on the mountain's top will be $= 39{\cdot}09$ inches; therefore by Huygen's proportions the ſpace deſcended in a ſecond of time on the top of the mountain will be $192{\cdot}9009$ inches; and the ſpace deſcended in a vibration of the clock is $193{\cdot}4437$ inches: And the gravity being defin'd by the ſpace paſs'd over in a ſecond of time. From corol. 2 prop. 5 theor. Principia Philoſophiæ; put $r =$ earth's radius, $x =$ mountain's height.

$r^2 + 2xr + x^2 : r^2 :: 193{\cdot}44 : 192{\cdot}9$.

And therefore $x = {\cdot}0014059r = 353375{\cdot}7768$ inches or $9815{\cdot}99$ yards or $5{\cdot}5773$ miles.

V. QUESTION 156 *anſwer'd by Mr.* John Turner.

Let $SD = t = 5$; $BS = c = 4$; $St = a$; $Dt = t + a$; and $At = t - a$. Then we have



As $tt : cc :: tt - aa : \frac{cctt - ttaa}{tt} =$ ſquare of tx. Ergo $tx = \sqrt{\frac{cctt - ccaa}{tt}}$ and $Cx = \sqrt{\frac{4cctt - 4ccaa}{tt}}$. This multiplied by $vt = 2a$, makes the area of the rectangle $ymxC = 2a\sqrt{\frac{4cctt - 4ccaa}{tt}} = \sqrt{\frac{16ccttaa - 16cca^4}{tt}}$: But this, by the queſtion, muſt be a maximum; therefore the fluxion of t which is $\frac{32ccttaa\dot{a} - 64cca^3\dot{a}}{2\sqrt{16ccttaa - 16cca^4}} = 0$. From hence $64ccaa = 32cctt$: And $a = t\sqrt{\tfrac{1}{2}} = 3{\cdot}535$: And $2a = vt$ is $= 7{\cdot}070$, and ym or $xC = 5{\cdot}657$. Again for the greateſt cylinder, ſuppoſing it to revolve about the tranſverſe axis, we found above $cx = \sqrt{\frac{4cctt - 4ccaa}{tt}}$. Ergo cx ſquared is $= \frac{4cctt - 4ccaa}{tt}$; this multiplied by $vt = 2a$ muſt, per queſtion, be a maximum. The fluxion of $\frac{8cctta - 8cca^3}{tt}$ is $8ctt\dot{a} - 24ccaa\dot{a} = 0$. Hence we have by diviſion and tranſpoſition $a = t\sqrt{\tfrac{1}{3}} = 2{\cdot}887$: And $vt = 2a = 5{\cdot}774$ the cylinder's altitude, and xc or my the diameter of the baſe $= 6{\cdot}532$. *Q.E.I.*

The

* *The propoſer's anſwer.*

Put $d = AD$, $c = nB$, $x = Dv$, $y = yv$.

Then $2y$ and $d - 2x$ the ſides of the parallelogram; the rectangle of which is $2yd - 4xy$, the fluxion of which, if a maximum, is $2d\dot{y} - 4\dot{x}y - 4x\dot{y} = 0$, $= d\dot{y} - 2\dot{x}y - 2x\dot{y} = 0$.

By the property of the ellipſe $dd : cc :: dx - xx : yy$. Ergo $y = \sqrt{\dfrac{dccx - ccxx}{dd}}$.

In fluxions $\dot{y} = \dfrac{dcc\dot{x} - 2ccx\dot{x}}{2d\sqrt{dccx - ccxx}}$. Which ſubſtituted in the

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* V QUESTION 156.

In the ſolution of queſtion 74, at page 181, it is proved that $CE = CA\sqrt{\frac{1}{3}}$, [*ſee the fig. to that ſolution*] and $EF = CD\sqrt{\frac{2}{3}}$; CE being half the height, and EF half the diameter of the cylinder, when CA is the ſemitranſverſe, and CD the ſemiconjugate axe.

Again, ſuppoſing CE and EF to be the halves of the length and breadth of the greateſt inſcribed parallelogram, by page 201 Simpſon's Geom. 2d edit. CE is $= \frac{1}{2}CT$, and $EF = \frac{1}{2}CK$; but, by the nature of the ellipſe, $CE : CA :: CA : CT$ or $2CE$; hence $CE = CA\sqrt{\frac{1}{2}}$. And in like manner $EF = CD\sqrt{\frac{1}{2}}$.

Corollary.

Hence, if t and c denote the whole tranſverſe and conjugate axes,

Then $t\sqrt{\frac{1}{2}}$ = length of the greateſt rectangle,
$c\sqrt{\frac{1}{2}}$ = breadth of the ſame,
$\frac{1}{2}ct$ = area of the ſame.
And $t\sqrt{\frac{1}{3}}$ = length of the greateſt cylinder,
$c\sqrt{\frac{2}{3}}$ = diameter of it,
$\dfrac{2c^2tn}{3\sqrt{3}}$ = content of it, putting $n = \cdot78539$ &c.

the former, we have $\frac{dcc\dot{x} - 2ccx\dot{x}}{\sqrt{dccx - ccxx}} - 2\dot{x}\sqrt{\frac{dccx - ccxx}{dd}}$ $- x \times \frac{dcc\dot{x} - 2ccx\dot{x}}{d\sqrt{dccx - ccxx}} = 0$. Which reduced, then $xx - dx + dd = -\frac{1}{8}dd$.

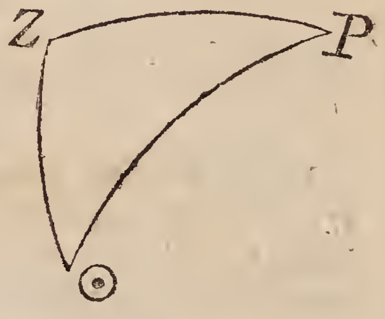
Hence $x = \frac{1}{2}d - \frac{d}{\sqrt{8}} = 1{\cdot}4645 = Dv$: from whence mx will be found $= 7{\cdot}071$; and $my = 5{\cdot}6568$: and the area of the greatest parallelogram $= 39{\cdot}999999$. *Q.E.I.*

VI. QUESTION 157 *anſwer'd by Mr.* Geo. Anderſon.

In contemplating on the ſolution of the 159th queſtion, I hit upon the following lemma, which I find to be ſo uſeful in ſolving aſtronomical queſtions of that kind, that I believe there can no ſuch queſtion be propoſed, but it will be found a uſeful inſtrument in ſolving it.

In the ſpherical triangle let P be the north pole, Z the zenith, ☉ the place of the ſun: And

$$\text{Put}\begin{cases} 1 = \text{radius,} \\ a = \text{tangent of } ZP, \\ s = \text{coſine of } ZP, \\ d = \text{right ſine } \odot P, \\ e = \text{coſine of } \odot P, \\ g = \text{coſine of } \odot Z, \\ x = \text{coſine of } \odot PZ. \end{cases}$$



LEMMA.

$\overline{e + dax} \times s = g.$

Corollary.

In queſtion 157 there is given the latitude of the place, and the altitude equal to the hour from noon and to the azimuth, to find the latitude of the ſtar (or declination with reſpect to the ſun); therefore in the room of g in the lemma put $\sqrt{1 - xx}$ (= ſine of the hour) and there will be had $\overline{e + dax} \times s = \sqrt{1 - xx}$, from the equality of the hour and and altitude. And now to anſwer the other parts of the queſtion, becauſe the azimuth is equal to the hour, therefore the ſame x ſtill repreſents the coſine of the angle ☉ ZP, and the theorem muſt be ſo tranſpoſed that ☉ ZP may be the angle contain'd: wherefore ſince ZP is one of the containing ſides of the angle ☉ ZP, as well as of the angle ☉ PZ, therefore

therefore a and s may ſtill retain their former office, but for d muſt be wrote $\sqrt{1-gg}$, and for e put g, and for g write e, and for e put x, and then the lemma will ſtand thus, $x + ax\sqrt{1-gg} \times s = e$. But becauſe $\sqrt{1-gg} = x$, the theorem will be $sx + saxx = e$; therefore from the two equations $e + ax\sqrt{1-ee} \times s = \sqrt{1-xx}$, and $x + saxx = e$, exterminate e you'll have this equation $s^8a^8x^{12} + 4s^8a^7x^{11} + 8s^8a^6x^{10} + 12s^8a^5x^9 \left.\begin{matrix}-2s^4a^4\\+14s^8a^4\end{matrix}\right\}x^8 \left.\begin{matrix}-4s^4a^3\\+12s^8a^8\end{matrix}\right\}x^7 \left.\begin{matrix}+2s^4a^4\\-4s^6a^4\\+8s^8a^2\end{matrix}\right\}x^6 \left.\begin{matrix}+4s^4a^3\\+4s^4a\\+4s^8a\\-8s^6a^3\end{matrix}\right\}x^5 \left.\begin{matrix}+2s^4\\-4s^6a^2\\+s^8\\+1\end{matrix}\right\}x^4 - 4s^4ax^3 \left.\begin{matrix}-2s^4\\-2\end{matrix}\right\}x^2 + 1 = 0$. Which in numbers reduced will give the coſine of the hour.

The propoſer's anſwer.

Let $\sqrt{1-aa}$ = ſine of $Z\odot$ or $P\odot$, b = ſine of ZP comp. lat. 60° 38′, n = ſine lat. 29° 22′, a = ſine of the altitude.

As $\sqrt{1-aa} : a :: b : \dfrac{ab}{\sqrt{1-aa}}$ = ſine $\angle Z\odot P$ and $1 - \dfrac{b^2a^2}{1-aa}$ = the ſquare of its coſine; $1-aa : 1 :: 1-n : \dfrac{1-n}{1-aa}$ = verſed ſine $\angle Z\odot P$, and $\dfrac{n-aa}{1-aa}$ = coſine $\angle Z\odot P$. Hence $\dfrac{nn-2naa+a^4}{1-aa} = 1 - aa - a^2b^2$. Reduced we have $a = \cdot 7493411$ = ſine of 48° 33″ = to the altitude and latitude of Perſeus's right ſide.

VII. QUES-

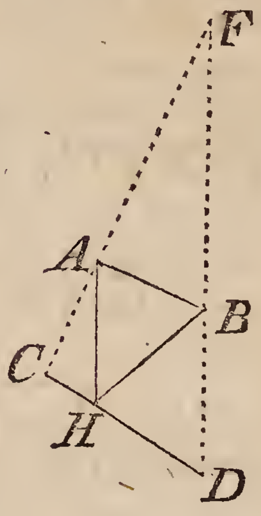
* VI. QUESTION 157.

In this queſtion, is given ZP, the $\angle Z = \angle P$ = comp. $\odot Z$ or $\odot P$, the triangle being iſoſceles. Then

Suppoſing a perpendicular demitted from $\odot$ upon and biſecting ZP, and thereby dividing $\odot ZP$ into two equal right-angled triangles; put a = the tangent of the baſe of each or of half PZ the given colatitude, and x = ſine of the hypothenuſe $\odot P$ or $\odot Z$ = coſ. $\angle P$ or Z; then, by right angled triangles, (radius =) $1 : x :: \dfrac{x}{\sqrt{1-x^2}}$ (= tang. $\angle P$ or Z) : $\dfrac{x^2}{\sqrt{1-x^2}} = a$; hence $x^4 = a^2 - a^2x^2$, and $x = \sqrt{a\sqrt{\tfrac{1}{4}a^2+1} - \tfrac{1}{2}a^2}$ = the coſine of the declination.

* VII. QUESTION 158 *answer'd by Mr.* J. Fearnside.

Let $DC = m$, $AB = b$, $AH = c$, $HB = a$, ſin. $\angle D = s$, its coſ. $= l$, ſin. $\angle CAH = r$, ſin. $HBA = u$, its coſ. $= t$, and $BF = x$. Then will ſin. $\angle F = \frac{b}{x}$, and its coſ. $= \sqrt{\frac{xx-bb}{xx}}$; ſin. $C = \frac{bl}{x} + s\sqrt{\frac{xx-bb}{xx}}$; $HC = \dfrac{cr}{\frac{bl}{x} + s\sqrt{\frac{xx-bb}{xx}}}$; ſin. $HBD = \frac{ub}{x} + t\sqrt{\frac{xx-bb}{xx}}$; and $HD = \frac{uba}{sx} + \frac{ta}{s}\sqrt{\frac{xx-bb}{xx}}$. Whence this equation $\dfrac{cr}{\frac{bl}{x} + s\sqrt{\frac{xx-bb}{xx}}} + \frac{aub}{sx} + \frac{ta}{s}\sqrt{\frac{xx-bb}{xx}} = m.$



Which reduced gives $x = 233{\cdot}10474$. Therefore $DF = 412{\cdot}5$, $CF = 427{\cdot}4$, and the area 1 ac. 1 r. 20 p.

This queſtion being unlimited, as not determined on which wall Bacchus or Apollo ſtands, will admit of another anſwer.

VIII. QUES-

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* VII. QUESTION 158.

In this queſtion it is required, about a given triangle to circumſcribe another triangle ſuch, that one of its angles, and one of the ſides about that angle, ſhall be each of a given magnitude; and the ſide oppoſite to the given angle perpendicular to a ſide of the given inſcribed triangle.

And hence if upon the given line BH be deſcribed the ſegment of a circle capable of containing the given angle D, the problem is reduced to this: To apply a line CD of a given length between the circumference of that circle and the line CF given in poſition, and ſo as to paſs through the given point H.

* VIII. QUESTION 159 *anſwer'd by Mr.* Anderſon.

Given the latitude, the ſun's declination, and the ſun's heat, as the ſine of his altitude and continuance above the horizon (viz. as their product) for ſo I take it, and was ſo inform'd by E. Stone, who propos'd the ſame queſtion in his preface to d' Hoſpital's fluxions.

Lemma

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* VIII. QUESTION 159.

Put s and c = the ſine and coſine of PZ, d and e = ſine and coſine of $P\odot$, m = the ſemi-diurnal arc, x = the hour arc or $\angle P$, y = its ſine, and z = ſine of the altitude or coſine of $Z\odot$.

Then $mz + xz$ = a maximum, per queſtion,

or $m\dot{z} + \dot{x}z + x\dot{z} = 0$.

But $z = ce + ds\sqrt{1-y^2}$, or $\dot{z} = \dfrac{-dsy\dot{y}}{\sqrt{1-y^2}}$; and

$$\dot{x} = \frac{\dot{y}}{\sqrt{1-y^2}}.$$

$$\text{Wherefore } \frac{-dsmy\dot{y}}{\sqrt{1-y^2}} - \frac{dsxy\dot{y}}{\sqrt{1-y^2}} + ds\dot{y} + \frac{ce\dot{y}}{\sqrt{1-y^2}} = 0,$$

$$\text{or } ce - dsmy - dsxy + ds\sqrt{1-y^2} = 0,$$

$$\text{and hence } x = \frac{ce - dsmy + ds\sqrt{1-y^2}}{dsy}.$$

Now this equation may be reſolved after ſeveral different manners. One method is to ſubſtitute in it the value, of x in terms of y in an infinite ſeries, and this will be like the two original ſolutions: Or a finite approximate value of x in terms of y may be ſubſtituted for it, and then the reſulting equation will be finite: Or ſome method may be uſed for approximating to the values of x and y immediately from the equation as it ſtands above, which will be eaſieſt and ſooneſt done; and the beſt method for that purpoſe ſeems to be this; by a few trials find $y = {\cdot}5$ nearly, which ſubſtituted in the above form, a near value of x will be found; from a table of ſines, to this value of x take the correſpondent value of y, which written in the above form again, there will be had a nearer value of x; and ſo on as far as neceſſary.

Lemma $\overline{e + dax} \times s =$ ſine ſun's altitude, as in queſtion 157. But $x + \frac{1}{6}x^3 + \frac{3}{40}x^5 + \frac{5}{112}x^7 +$ &c. is the arch belonging to x, and $b - x - \frac{1}{6}x^3 - \frac{3}{40}x^5 - \frac{5}{112}x^7$ &c. (putting $b = \frac{1}{4}$ of the circumference) is the complement of it, and therefore the hour from noon: Put $r =$ the time (viz. the length of the arch of the equinoctial) paſs'd over from ſun-riſing to noon; Now it is manifeſt the aforeſaid phænomenon will not happen before the ſun's arrival at the meridian, therefore $r + b - x - \frac{1}{6}x^3 - \frac{3}{40}x^5 - \frac{5}{112}x^7 -$&c. is the ſun's continuance above the horizon, and this multiplied by $se + sdax$ the ſine of the altitude, and thrown into fluxions and reduced gives $2sdax + \frac{1}{2}sex^2 + \frac{2}{3}sdax^3 + \frac{3}{8}sex^4 + \frac{9}{20}sdax^5 + \frac{5}{16}sex^6 + \frac{5}{14}sdax^7 +$ &c. $= sdar + sdab - se - m$. And therefore $x = \frac{m}{2sda} - \frac{m^2}{2se \times \overline{2sda}|^2} + \frac{3ees - 4da}{4da} \times \frac{m^3}{\overline{2sda}|^3} -$ &c.

The propoſer's anſwer.

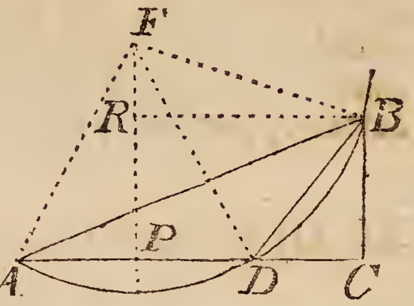
Let $m =$ the rectangle of the ſine com. lat. and co-declination, $p =$ ſun's alt. at 6, $n =$ the length of the ſemi-diurnal arch, and z the length of the arch from noon. The coſine of the hour angle from noon is $= 1 - \frac{zz}{2} + \frac{z^4}{24} - \frac{z^6}{720}$ &c. and, putting $m + p = a$, the ſine of the ſun's altitude will be $= a - \frac{mzz}{2} + \frac{mz^4}{24} - \frac{mz^6}{720}$, &c. Which multiplied by $n + z$, and thrown into fluxions, &c. gives $mnz + \frac{3m}{2}z^2 - \frac{mn}{6}z^3 - \frac{5m}{24}z^4 +$ &c. Revers'd z will be $= \cdot 50614$ (the radius being 1) conſequently the hour is 1 h. 56′ afternoon.

IX. QUES-

IX. QUESTION 160 *anſwer'd by the author Mr.* Maſon.

Let $AD = b = 40$, $BC = c = 23$, $d =$ s. $\angle ABD = 30°$, $a = DC = ?$

Per 47 E. 1, $\sqrt{b^2 + 2ba + aa + cc} = AB$; for which ſubſtitute y: then $y : 1 :: c : \frac{c}{y} =$ s. $\angle BAC$; and $d : b :: \frac{c}{y} : \frac{bc}{dy} = DB$; per 47 E. 1, $\frac{bbcc}{ddyy} - cc = aa$. i.e. $bbcc - ccddyy = ddyyaa$: for yy put its value. Then $a^4 + 2ba^3 + bbaa - 2bca = \frac{bbcc}{dd} + c^4 - bbcc$: which reduced gives $a = 18{\cdot}3$, $AB = 62{\cdot}672$, $DB = 29{\cdot}392$.



Anſwer'd by Mr. John Bulman.

On the given ſegment $AD = 40$ chains (per 33 Eucl. 3) deſcribe a ſegment of a circle which ſhall contain the given angle $ABD = 30°$. And from F the center thereof let fall the perpendicular FP upon AD; make $PR = 23$, and draw RB parallel to AD meeting the circle in B; and let fall the perpendicular BC. Then the lines FB, FD, FA will all be equal as being radius's of the ſame circle.

The angle AFD is double the angle ABD (per 20 E. 2); therefore the triangle AFD is equilateral, and conſequently equiangular, each ſide being 40 chains, and each angle 60°. Then $FD^2 - PD^2 = FP^2$ (per 47 E. 1); whence $FP = 34{\cdot}641$, and $FP - BC = FR = 11{\cdot}641$. Again $FB^2 - FR^2 = RB^2$; whence $RB = 38{\cdot}2686$, and $RB - PD = DC = 18{\cdot}2686 =$ the diſtance of the neareſt mark from the end of the firſt line: Hence BD may eaſily be found $= 29{\cdot}3628$ chains, and $BA = 62{\cdot}6438$. *Q. E. I.*

X. QUESTION 161 *anſwer'd by the author.*

The longitude is 20′ 23″ 2‴ 24⁗; from which and two latitudes is found the tower's diſtance 26′ 12″. The arch of diſtance between the ſhip and horizon is 7′ 5″ 16‴ 48⁗ + 26′ 12″ = 33′ 17″ 16‴ 48⁗. By which 326·15264 yards is the tower's height, and 56·6202 leagues the iſland's compaſs, alſo the area 2193·2553 ſquare miles.

Several have attempted the ſolution of this queſtion; but differ widely from the author, viz. Mr. *Grimmett* and Mr. *Bulman* make the iſland's compaſs 657 leagues; Mr. *Ommanney* 50 leagues; others 26 leagues: And not knowing after what method the author proceeded for his anſwer, or whether there be not ſome miſtake in the manuſcript of this queſtion; I ſhall wave giving thoſe other methods till a better opportunity ſhall ſet this matter right.

XI. QUESTION 162 *anſwer'd by the propoſer Mr.* Maſon.

$$A = 404 : B = 465.$$

Mr. Robert Fearnſide's *anſwer.*

Let $2y =$ ſum of the aliquot parts in A; and $3z =$ ſum of the aliquot parts in B: Then $3y$ will be $=$ ſecond number B; and $4z = A$. Now $1 + 2 + 4 + z + 2z = 2y$; and $1 + 3 + y = 3z = 2y - 7$. Conſequently the firſt number A will be found to be 20, and $B = 33$.

For $1 + 2 + 4 + 5 + 10$ is $= \frac{2}{3}B$; and $1 + 3 + 11$ is $= \frac{3}{4}A$.

Mr. Grimmett's *anſwer.*

It is ſuppoſed that $\frac{3}{4}$ of A is an integer, becauſe the ſum of the aliquot parts in B is $=$ to it; and likewiſe $\frac{2}{3}$ of B is an integer for the ſame reaſon; therefore the number A muſt be a multiple of 4; and the number B a multiple of 3. Make therefore $A = 4a$; its aliquot parts are $2a$, a, 4, 2, 1 the ſum of which is $3a + 7$. Put alſo $B = 3e$; the ſum of the aliquot parts of which is $e + 4$; and per queſtion $3a + 7 = 2e$ $(= \frac{2}{3}B)$; alſo $e + 4 = 3a$ $(= \frac{3}{4}A)$. Whence a is found $= 5$, and $e = 11$. Conſequently $4a = 20 =$ the number A; and $3e = 33 = B$.

The Prize Queſtion anſwered by Mr. Rob. Fearnſide.

Let $x^6 = A$, $y^6 = B$, $z^6 = C$; then $\frac{z^6}{6} + \frac{x^6}{5} = \frac{x^6}{6} - z^6$; conſequently $x = z\sqrt{\frac{10}{4}}$ and $x = y\sqrt{\frac{10}{6}}$: Now by Ward's

Theorem,

Theorem, p. 271, we ſhall have (putting $r = \sqrt[3]{\frac{2}{3}m} = 1{\cdot}50363$, $n = 1{\cdot}06$) $\frac{nm^2x^3y^3 - m^2x^3y^3}{m = 1} = 22xx =$ rent whence by ſubſtitution, &c. $x^2 = \frac{m-1}{n-1} \times \frac{r}{sm^2} = 3{\cdot}5316$. Then $x^6 = A = 44{\cdot}047579$, $B = 26{\cdot}423547$, and $C = 17{\cdot}61903$.*

The

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* *The* PRIZE QUESTION.

In this queſtion, for determining the three quantities, x, y, z, there are given the two equations $x + y = z$, and $y + \frac{z}{5} = x$: And the third equation is to be made out from theſe following conditions, viz. that $\sqrt{xz}$ is the preſent value of a yearly rent, which is expreſſed by $\sqrt[3]{yz}$, to continue for 7 years, but the firſt payment not to become due till the end of the 8th year; the intereſt of money being reckoned at 6 per cent.

From the two firſt equations we eaſily find $x = \frac{3z}{5}$, and $y = \frac{2z}{5}$; conſequently the yearly rent becomes $\sqrt[3]{\frac{2z^2}{5}}$, and the preſent of it $\sqrt{\frac{3z^2}{5}}$ or $z\sqrt{\frac{3}{5}}$. But by any calculated table of reverſions at 6 per cent. it appears that the preſent worth of one pound due 8 years hence is ·6274, the preſent value due 9 years hence ·5919, the ſame for 10 years ·5584, for 11 years ·5268, for 12 years ·4970, for 13 years ·4688, and for 14 years ·4423; the ſum of theſe is 3·7126 which is the preſent value of 1 for thoſe 7 years, and conſequently $3{\cdot}7126\sqrt[3]{\frac{2z^2}{5}} =$ the preſent value of $\sqrt[3]{\frac{2z^2}{5}}$ annuity for the ſame time, and which muſt be equal to $z\sqrt{\frac{3}{5}}$, that is $3{\cdot}7126\sqrt[3]{\frac{2z^2}{5}} = z\sqrt{\frac{3}{5}}$; hence then z is $= 3{\cdot}7126^3 \times \frac{2}{3}\sqrt{\frac{5}{3}} = 3{\cdot}7126^3 \times \frac{2\sqrt{15}}{9} = 44{\cdot}042$. Conſequently $x = \frac{3z}{5} = 26{\cdot}4252$, and $y = \frac{2z}{5} = 17{\cdot}6168$.

The same otherwise answered.

Let	1	$a =$ the cash to be divided,
	2	$b = B$'s part,
	3	$c = C$'s part.
Then	4	$b - \frac{a}{5} = c$ per question
$2+4$	5	$2b - \frac{a}{5} = a.$
$5\times\overline{5}+a$	6	$10b = 6a.$
$6\div\overline{6}$	7	$\frac{10b}{6} = a.$
$7\div\overline{5}$	8	$\frac{10b}{30} = \frac{b}{3} = \frac{a}{5}.$
$2-8$	9	$\frac{3b-b}{3} = \frac{2b}{3} = C$'s part.
7×2	10	$\frac{10bb}{6} =$ the square of the purchase.
7×9	11	$\frac{10bb}{9} =$ the cube of the yearly rent.
Substit.	13	$m^2 = \frac{10}{6}$
Then	14	$mmbb = \frac{10bb}{6}$
14 extr.	15	$mb =$ the purchase (which per Ward, p. 246 theo. 1)
Will be	16	$rtmb + mb =$ the value at the time of purchase, which per 2d theor. Ward, p. 249.
Will be	17	$\frac{2rtmb+2mb}{ttr-tr+2t} = u$ $\begin{cases}\text{put } 2tm = x\text{; and } 2m = z\text{;}\\ \text{and } ttr - tr + 2t = d.\end{cases}$
Then	18	$\frac{xb+zb}{d} = u.$
18 cub.	19	$\frac{x^3b^3+3xxzb^3+3xzzb^3+z^3b^3}{d^3} = \frac{10bb}{9}$
$19\times\&\div$	20	$b = \frac{1\frac{1}{9}ddd}{x^3+3xxz+3xzz+z^3} = 101{\cdot}730562$
		C's part $= 67{\cdot}820375$
		Cash to be divided $= 169{\cdot}550937$
		The annuity or income $= 22{\cdot}577929$

The prize of 10 diaries fell to Mr. *Rob. Fearnside.*

End of the First Volume.

RB.